Product Quality, Consumer Information and "Lemons" in Experimental Markets

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I. Introduction

This paper reports on the behavior of experimental markets wherein buyers were ignorant (unless truthfully informed by sellers) of the quality of the product purchased. True quality of the product was learned only after the sale. Sellers chose quality or "grade" and higher quality was more costly to produce. Our experimental markets were characterised by asymmetric information possessed by buyers and sellers who traded a pure "experience" good whose quality was endogenously determined.

Some theories predict that such markets will ultimately consist only of the lowest quality goods, that is, only "lemons" will be traded. Bad quality drives out good, in spite of the fact buyers are willing to pay the added cost of higher quality. This "lemons" outcome is clearly inefficient, because both buyers and sellers could be better off if higher quality goods were also produced. The inefficiency is due to the failure to effectively share the sellers' information on quality with the buyers. Thus the "lemons" equilibrium is one type of informational market failure, perhaps the simplest one that has been analytically modeled.

The "lemons" model itself is of more than academic interest to the FTC. The FTC staff (1978) explicitly referred to and used this model to argue the merits or lack thereof of (most appropriately, at least in an etymological sense) the proposed Used Car Rule. The model has also been explicitly invoked in various housing warranty cases. Less explicit but quite conscious use of the main theme of this model appeared in the Staff Report on Life Insurance (1979).

It is also of interest as a special case of a general problem. Under what conditions may market inefficiency be caused by a lack of consumer information or by seller provided misinformation? Alternatively, under what conditions are regulations penalizing deceptive or misleading seller claims, or government mandated disclosures or standards likely to improve market performance? This is clearly a central question for consumer protection policy—both for formulating the basic principles of policy and for allocating resources efficiently to implement them.

Some general answers have been given, and at this general level there seems to be considerable agreement, even among those who often disagree on specific policy issues. Both Posner (1973, 1979) and Pitofsky (1979), for example, agree

that disclosure problems are most likely to arise for products or services that either have important "hidden characteristics" or that are infrequently purchased and expensive. A hidden or a "credence" characteristic is one that would not become apparent in normal use or consumption (*e.g.*, cholesterol content of butter or margarine). In either case, sellers may have little incentive to disclose a negative characteristic because failure to do so will not harm future sales, whereas disclosure may hurt present sales. Both also appear to agree that there is little reason to think that disclosure problems will ever arise for frequently purchased experience goods.

Agreement at this general level does not imply agreement on any specific issue, as a perusal of the Posner-Pitofsky exchange will quickly show. "Natural" markets, like that for used cars or new home warranties or new life insurance policies, are extremely complicated. Firms may pursue very diverse marketing strategies in different market segments. Consumers in different segments may have very different information on product quality. It is often very difficult to determine whether there has been any "failure" in such markets and even more difficult to test alternative theories of the cause of failure. Reputation effects could be very powerful, but extremely difficult to measure. The artificial experimental markets we have created have fewer complications and allow us to unambiguously identify "failure" when it occurs.

The study was designed with one primary objective and several secondary objectives. The primary objective was to investigate circumstances in which the "lemons" phenomena will arise in markets. The design of the markets, the market organization and institutions, were guided by models found in economic literature. Thus, the pursuit of the primary objective implicitly involved adding operational content to various theories as well as tests of the reliability of the resulting models. The secondary design objective, predicated upon the assumption that the first objective would be successfully attained, was to check the sensitivity of the "lemons" phenomena to parameters and regulations that some theories and policy arguments suggest will eliminate the phenomena and increase market efficiency.

The broad questions posed and answered by the research are as follows: (1) Can "lemons" problems occur in markets? Our answer is "yes" in the sense that we have designed markets in which it can be observed with substantial reliability. (2) Are express warranties an effective remedy if the lemons phenomena are viewed as a market failure? In our experimental markets express warranties and truthful advertising are the same thing. Regardless of the interpretation, the answer in the markets we studied is "yes." (3) Where quality is easily ascertainable after purchases (experience goods) will sellers form reputations that guarantee efficient market performance? Our answer is "not necessarily." We are then able to isolate some conditions that will help the reputation formation process. The "hidden" characteristics problem was not in the current experimental design, except in a very minor way. In studying and answering these three broad questions we pose several specific hypotheses that are suggested by both the data and existing ideas about the evolution of informational efficiency in markets.

The following section is an outline of the experimental design, procedures, and parameters. The third section is a discussion of models that might reasonably be expected to apply to the setting. The fourth section is a discussion of results, and the final section is a summary.

II. The Market and Regulatory Environments, Experimental Design, and Procudures

A. *Parameters*

A total of *twenty-one* markets were conducted plus some pilot experiments. Participants were students at Boston University (BU) California Institute of Technology (Caltech), and Pasadena City College (PCC). Some of these participants were involved in several markets as a control for experience.

All markets proceeded as a series of market days or trading periods. The number of periods was unknown to participants, but, because they knew roughly the maximum time of the experiment (three hours), they had some idea of when the last periods were approaching. Sellers remained sellers throughout an experiment and buyers remained buyers.

Sellers could supply units of grade Super or Regular. Each seller was limited to a total supply of two units per period. The units could be any combination of grades possible as long as each seller supplied a total of two or less units. Thus, the seller could sell two Rs, two Ss, one of each, one unit of some type, or nothing. The fact that Supers were more costly to sellers than were Regulars was public information. Both Supers and Regulars were supplied at constant marginal cost up to the limit of two units in total. For "high cost" experiments, which are all but selected periods of experiments 19 and 21, the (constant) marginal cost of Supers was 100 francs (one dollar) more than the (constant) marginal cost of Regulars. In the low-cost experiments, this difference in marginal cost was reduced to either 20 or 25 francs.

Buyers' redemption value of Supers was more than Regulars and this was public information. The redemption value for buyers is in Figure 1. As can be seen, the marginal valuation of a Super always dominates the marginal valuation of a Regular. Thus, given a choice of a Super or Regular, a buyer would always prefer a Super until a limit of three Supers is attained and the marginal valuation falls to zero. All buyers had identical redemption schedules.

For a typical experiment with eight buyers and six sellers the market demand and supply are presented in Figure 1. The values are in an experimental currency called "francs" that have a dollar conversion factor. As can be seen, the market supply is horizontal for twelve units and then becomes vertical.

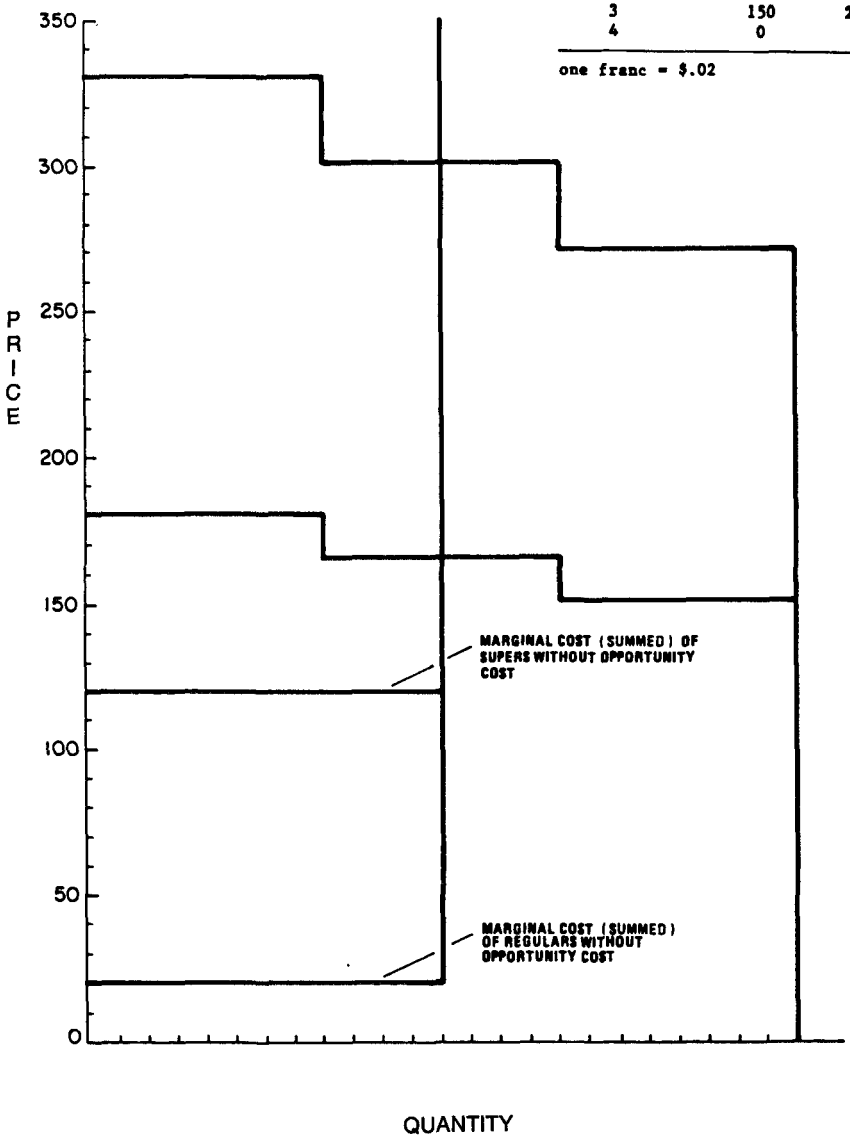
All transactions were in an experimental medium of exchange called francs. Francs could be converted to dollars at a predetermined rate known only to each individual. Prior to some markets, subjects were told that the dollar per franc conversion rate might be scaled upward after the experiment. In early experiments in which little was known about behavior and parameters, the value

Figure 1

BUYER REDEMPTION VALUES IN FRANCS

Unit Number	Regular	Super
1	180	330
2	165	300
3	150	270
4	0	0

one franc = $.02



of francs was increased so that on average participants earned about $5 to $7 per hour. This was thought necessary in order that the experienced subjects would be willing to participate again.

In addition to profits earned from purchases and sales, buyers were given a bonus of 50 francs each period and an unexpected one-time endowment of 200 francs at the end of the first period. Early pilot experiments demonstrated a potential problem of credibility and control, which the bonus helped to eliminate. During the first period inexperienced buyers would pay high prices for units on the expectation that sellers would deliver Supers. When Regulars were actually delivered, the buyers suffered substantial losses. Once operating at a loss, they seemed to suspect that the experimenter would not collect money from the subjects, so they had little to lose from further losses. With perceived downside risk gone, control over incentives was lost. The surprise bonus was sufficient to bring all buyers back to a profitable position. When the surprise bonus was given to buyers, they were told to expect no more bonuses. Of course we had no real control over expectations, so we were potentially trading one problem for another.

B. *Market and Regulatory Variables*

Institutional variables were those that deal with market organization, information, and the rights and guarantees afforded to participants. The institutional variables are the treatment variables. When and how did the grade of a unit become known to a buyer? What guarantees were available to buyers of Regulars who thought they were buying Supers? When and how did the sales record of individual sellers become known? Answers to these questions define the institutional structure of the markets. These institutional features will be discussed after the features common to all markets are outlined.

B.1 The Basic Market Organization

The basic market organization was the same for all markets. Buyers and sellers were located in different rooms. Communication between rooms was accomplished by citizen band (CB) radios. Each room had an experimenter in front of the room equipped with a large chalkboard and a CB radio. A long horizontal line scaled from zero to infinity francs was displayed on the chalkboard. Buyers submitted bids that were transmitted to the seller room over the CB by the experimenter. At the same time the experimenter in the buyer room entered the bid under the horizontal line at the franc value equal to the bid. When the bid transmission was received in the seller room, the experimenter repeated the bid and entered it under the horizontal line at the appropriate value. Similarly, when sellers tendered offers, the offer was entered above the line at the appropriate value and transmitted to the buyer room where it was verbally repeated and entered on the chalkboard. If two bids (offers) were tendered at the same price, the second one was listed below (above) the first one. Thus the time of tender is partially ordinally indexed by distance from the line.

Bids and offers remained open until accepted or canceled. Buyers or sellers accepted offers/bids verbally by indicating to the experimenter the one they wanted from those on the chalkboard. Traders were free to indicate the particular bid or offer they wanted independent of the temporal order of tender. An acceptance was immediately radioed to the other side of the market over the CB. Of course, since the CB transmitter and receiver were located in the room with agents, all transmissions over the radio were public. Once a trade was made the bid/offer was circled on the chalkboards and numbered. Aside from bids, offers, acceptances, and other necessary communications with experimenters, the participants were not allowed to say anything. No talking was permitted.

B.2 Regulatory Environment

The major treatment variables were warranties, warranty enforcement, identification of the seller of units, and the timing and public or private nature of grade revelation. These variables are discussed in order.

Warranties, when they existed, were express warranties[1] generated by a claim or grade advertisement by the seller prior to the buyer's purchase. In some cases sellers and buyers could do nothing other than make bids and offers with no reference at all to the grade of the unit. This condition is designated as "N" because no warranties of any sort existed or could exist. Under a different condition, condition "O," sellers had the option of advertising a unit as a Regular or Super at the time an offer was tendered to the market. The offer was then tagged on the chalkboard as an S or R according to the seller advertisement. Likewise, under the "O" condition buyers had the option of indicating along with a bid the grade of the unit desired. A third condition, "R," required sellers to advertise or disclose units as either a Regular or a Super at the time of an offer and required buyers to indicate with all bids, the grade of the unit desired. Thus, the regulatory environment governing warranties could be any of the conditions (N,O,R).

Warranties could be unenforceable (condition U) or enforceable (condition E). If warranties were unenforceable, no regulations existed governing the cases in which sellers failed to deliver the grade that was promised in the advertisement or requested by the buyer. That is, sellers could advertise a unit as a Super but deliver a Regular and the buyer could do nothing about it. In essence, false advertising was permitted. If warranties were enforceable (condition E) buyers were granted "specific performance."[2] That is, the seller was required

[1] Section 2-313 of the uniform commercial code requires: (a) Any affirmation of fact or promise made by the seller to the buyer which relates to the goods and becomes part of the basis of the bargain creates an express warranty that the goods shall conform to the affirmation or promise. (b) Any description of the goods which is made part of the basis of the bargain creates an express warranty that the goods shall conform to the description.

[2] Consistency of this regulation with the uniform commercial code is covered in Section 2-716.

(footnote cont'd)

to deliver a Super to the buyer if the unit had been so advertised. Thus, the enforcement condition could take two values (U,E).

In some markets sellers' identification numbers accompanied all offers and bids transmitted over the CB. Furthermore, under such conditions buyers were able to direct bids to individual sellers and such tagged bids could only be accepted by the requested sellers. This condition is designated as K to indicate that sellers'' (but not buyers'') identifications were known at the time of a contract. In the alternative condition U, neither buyer nor seller ever knew the identity of a trading partner. Thus, the identification variable took two values (U,K).

Unless grades were covered by an enforced express warranty, buyers became aware of grade either immediately after the purchase (condition A) or at the end of a period (condition E). Under condition A the seller held up a card immediately after the sale with letter S or R indicating the unit as Super or Regular. The information was then transmitted by the experimenter to the buyer. Under condition E the seller would submit a slip of paper indicating the grade for each trade in which the seller was involved. Trades were numbered on the chalkboard and sellers and buyers would record the number attached to each trade along with the price, etc.

The case in which the enforced warranty is provided is a little hard to describe notationally. If a grade was advertised, which need not be the case under condition ''O,'' the buyer was aware of the grade prior to purchase. Thus the notation B is used. The actual announcement, however, could have been ''A'' or ''E.''

Some interpretations are in order. An enforced warranty can be interpreted as a case in which all characteristics of the product can be fully identified and evaluated by the customer prior to purchase. If the grade becomes known immediately after the sale, the customer has no recourse from unfulfilled expectations except alterations in future purchase patterns. Since the information becomes available immediately after a purchase, the consumer can react through modifications of purchasing behavior for the remainder of the period as can other buyers if the information is public. If the information becomes available only at the end of a period, the consumer is faced with a type of ''credence'' problem. During a period the consumers are unable to evaluate purchases. The information that permits evaluation becomes available only after a delay.

Information about grade was either publicly revealed (condition Pub.) or privately revealed (condition Pvt.). In the case of public revelation the informa-

(1) Specific performance may be decreed where the goods are unique or in other proper circumstances. (2) The decree for specific performance may include such terms and conditions as to payment of the price, damages or other relief as the court may deem just. (3) The buyer has a right of replevin for goods identified to the contract if after reasonable effort he is unable to effect cover for such goods or the circumstances reasonably indicate that such effort will be unavailing or if the goods have been shipped under reservation and satisfaction of the security interest in them has been made or tendered.

tion regarding grade communicated to the experimenter was then announced over the CB for all to hear including the buyer. If the information was privately revealed, the slip indicating grade was passed along to the buyer or a cipher was used to privately transmit the grade over the CB. The latter procedure was useful if the rooms were so far apart that physical delivery of slips slowed the process excessively.

C. *Experimental Design*

A total of twenty-one markets was studied. The treatment variables included experience on the part of buyers and sellers, the relative cost of Supers, and the regulatory variables listed above. Obviously, with the large number of potential treatment variables not all possible experiments could be conducted. The strategy was to follow the sequential process outlined in the introductory statements. The choice of a particular experiment depended in part upon the availability of subjects and the pattern of previous results.

The treatments chosen for each of the twenty-one markets are listed in Table 1. The conditions of an experiment are indicated by an 8-tuple.

1	2	3	4
Warranty Offered (N,R,O)	Warranty Enforcement (U,E)	Trader I.D.'s (U,K)	Time of Grade Revelation (B,A,E)
5	**6**	**7**	**8**
Method of Grade Revelation (Pub,Pvt)	Experience (N,E,VE)	Relative Super Cost (L,H)	Location (BU,CIT,PCC)

For example, the index (O,E,U,B,Pub,VE,H,PCC) is a market in which warranties were optional but enforced if provided; trader I.D.'s were unknown; grades were known before purchase because warranties were enforced; the grades were publicly announced; traders were very experienced; the cost of Supers was in the relatively high condition; and the experiment was conducted at Pasadena City College.

Subjects with no experience (N) had participated in no experiments of the type under examination here, but some subjects from Caltech had participated in market experiments of a different type and were thus somewhat familiar with a market experimental environment. Experienced (E), subjects had participated in at least one previous experiment in this series. In almost all cases of new subjects the first market experience involved at least two different treatment

variables that resulted in different patterns of market price so that afterwards subjects were all somewhat familiar with aspects of the parameters. Very experienced subjects (VE) had participated in at least two previous experiments.

The description of the other variables must proceed with the discussion in the section above. The easiest way to understand the variables is to notice that advertising and the warranty are tied together in interpretation. If a grade is specified along with a bid or offer, it is viewed as both advertising and a warranty. The two are equivalent, because if a grade specification is available to any buyer, it is available to all. The interesting additional variable is whether or not the warranty is enforced or, equivalently, whether or not the advertising must necessarily be truthful. A "defective unit" backed by an unenforceable warranty is equivalent in these markets to an advertisement about grade that is false. As will be discussed in the parameter section below, the cost to sellers of delivering Supers was always higher than Regulars. If the difference was 100 francs ($1) per unit, the cost was in the high (H) condition. If the cost difference was 20 francs ($.20) or 25 francs ($.25) per unit, the condition was low (L).

D. *Experimental Procedures*

Subjects were recruited from BU undergraduate business and PCC undergraduate economics classes and from Caltech dorms. The "sales pitch" included with the instructions in Appendix A contains the essence of the information given subjects when they were recruited. All were told that the experiment would take approximately three hours. They were told that we could not guarantee an amount, but that they would have an opportunity to make "more than they would likely make in a comparable hourly period," that "we have never had a dissatisfied customer," and that "we were interested in studying situations in which people make decisions that matter, so we provided incentives accordingly." Such statements were intended as assurances that the stakes could at least cover their opportunity cost. Of those that signed up at PCC, approximately 65 percent actually showed up. The rates were higher at BU and Caltech.

At the assigned time and location the number of subjects present were counted and a decision was made about the number of buyers and sellers.[3] Subjects were randomly assigned instruction sheets as buyers or sellers. Buyers were on one side of the room and sellers were on the other side. Forms in the instructions were reproduced on the chalkboard. Instructions were then read, questions were answered. The market process was explained, including the bids and offers process, the chalkboard, and the determination of Supers and Regulars. If warranties or advertising were involved, special instructions regarding these were included.[4] After all questions were answered, sellers were then accompanied to another room.

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[3] We preferred to have two more buyers than sellers. This would assure unique price predictions by certain models.

[4] *See* appendix.

Table 1

A List of Conditions, Subject Pools and Parameters Used in all Experiments

Key to Abbreviations

Column 3	Column 4	Column 5
N = no	E = yes	U = unknown
R = required	U = no	K = known
O = optional		

1	2	3	4	5	6	7	8
					Information about Grade		
Exp. No.	Location	Grade Warranty Requirement	Grade Warranty Enforcement	Seller* Identification	Time	Method	Subject Experience
1	BU	N	-	U 1-6 K 7,8	E	pvt	N
2	BU	N	-	U	E	pvt	N
3	BU	R 1-6 N 7-9	E -	U U	B E	pub pvt	N
4	BU	R 9-8 N 9,11	E -	U U	B E	pub pvt	N
5	BU	N	-	K	E	pub	N
6	BU	N	-	K	E	pub	E
7	BU	N	-	K	E	pub	E
8	CIT	N 1-6,9,10 R 7,8	- E	U U	E B	pvt pub	N
9	PCC	N 1-8 R 9-11	-	U U	E B	pvt pub	N
10	PCC	N 1-6 O 7,8	- E	K K	E B	pub pub	N
11	CIT	N	-	K 1-8 U 9-10	E	pub 1-8 pvt 9,10	8-E 6-N
12	PCC	N 1-6 O 7	- E	K	A	pub	N
13	PCC	N 1-6 O 7	- E	K	A A	pub pub	N
14	PCC	N 1-7 O 8,9	- U	K K	A	pub	N
15	CIT	N	-	K	E	pvt	5-VE 6-E 3-N
16	PCC	N 1-7 O 8,9	- E	K	A	pub	E
17	PCC	N 1-8 R 9	- E	K	A	pub	3-VE 8-E 2-N
18	PCC	N 1-6 O 7,8,9 R 10,11	- U E	K	A	pub	5-VE 9-E
19	PCC	N 1-3 O 4-14	- U	K	A	pub	2-VE 5-E
20	CIT	N	-	K	E	pvt	N
21	PCC	N	-	K	A	pub	VE

* Buyer identifications were always unknown except periods 7 and 8 of experiment 1.

Key to Abbreviations

Column 6	Column 7	Column 8
B = before purchase	pub = public	N = none
A = after purchase	pvt = private	E = experienced
E = period end		VE = very experienced

1	9	10	11	12	13	14	15
	Cost		Number		Full Information Competitive Equilibrium Price**		
Exp. No.	Supers	Regulars	Buyers	Sellers	Supers	Regulars	Total Number Periods
1	120	20	7	6	300	165	8
2	120	20	7	6	300	165	7
3	120	20	5	4	300	165	9
4	120	20	8	6	300	165	11
5	120	20	8	6	300	165	7
6	125	25	8	6	305	170	12
7	125	25	8	6	305	170	12
8	120	20	6	6	300	165	10
9	120	20	7	6	300	165	11
10	120	20	8	6	300	165	8
11	120	20	8	6	300	165	10
12	120	20	8	6	300	165	7
13	120	20	8	6	300	165	7
14	120	20	8	6	300	165	9
15	120	20	8	6	305	170	10
16	120	20	8	6	305	170	9
17	120	20	7	6	305	170	9
18	120	20	8	6	305	170	11
19	120 (7-14)40	20 20	5	1(6)***	300	165	14
20	120	20	8	6	300	165	9
21	125 (5-14)45	25 20	8	6	305	170	14

** $/F was .02 for buyers and .01 for sellers. Buyers received 50F per period endowment plus a one-time unexpected payment of 200F after period 1.

*** The monopolist has the capacity of eight sellers.

When buyers and sellers were in separate rooms, questions were again answered. Buyers completed a period zero.[5] They were also warned that they must keep accurate records and note the transaction numbers. If we found anyone who "mistakenly" recorded Regulars as Supers, we would need to terminate the experiment.[6] The market opened for period one and it remained open for seven minutes as opposed to the usual five. After period one the extra bonus of 200 francs was given to buyers in addition to the 50 franc per period endowment. Buyer and seller record sheets were checked after the first, second, and third periods and occasionally after that.

III. Models and Ideas

Ideas and models are outlined in five different categories. We have applied the models to generate a prediction, but the reader should notice that with all of the ideas outlined in this section some latitude exists regarding how a model might best be applied to the markets we created. For example, some models found in the literature are supported by analysis that involves the reasoning process that agents undertake, what they observe, and how they process these observations. Since we did not have access to such data, theories that rest on such ideas remain untested. Instead we applied the models using those operational concepts and measurements that were available and seemed reasonable.

A. *The Full Information Model*

This idea rests on the hypothesis that the markets will behave as if all information about the underlying state of nature available to any agent will be revealed to all through the market process. A natural assumption would be that this model could only be applicable in cases where the buyer knows the seller, or some form of direct communication is possible. However, it is conceivable that the predictions of the model be borne out even when such special conveniences are absent. Sequences of bids, special prices, special offers, etc. could all serve as some sort of signal. Any market is filled with such possibilities, so the model could generate good predications even in cases where buyers and sellers have far less than full information.

The idea is as follows. Each seller presumably knows the quality of a unit to be sold at the time an offer is tendered.[7] The state of nature is thus the pattern of Supers and Regulars offered on the market. The hypothesis is that buyers

[5] *See* instructions. Each buyer was required to list the redemption values in the practice record sheet assuming a sequence of purchases S, R, R, S in period 1 and RSR in period 2. This exercise removed certain confusions about the redemption values.

[6] Fortunately the only cheating problems we detected were in the pilot experiments that caused us to add this statement.

[7] In most markets the seller need not commit to a grade until after a sale. We assume, however, that the decision about gradeis made before an offer is tendered.

will behave as if they can distinguish between offers of Supers and Regulars. Sellers will develop a profit maximizing response to buyer decisions. Application of the laws of supply and demand yield a prediction that only Supers will be sold at a price of P_S (*see* Table 1).

B. *Null Expectations Model*

This idea rests on the hypothesis that buyers without prior instruction on the likelihood of Supers and Regulars will treat them as equally likely. The rational expectations postulate is not applied and neither is a substitute learning axiom. So expectations are postulated to be unchanging. Sellers will adopt a profit maximizing response to this behavior. If Supers and Regulars are expected to be equally likely, application of the laws of supply yields a prediction that all Regulars will be sold at a price equal to the average of P_S and P_R (*see* Table 1).

Clearly a null expectations model could involve any probability at all. The choice of 50:50 is arbitrary. The model is used primarily as a point of reference.

C. *Lemons Model*

Sellers, faced by buyers who behave as if they cannot distinguish Regulars from Supers will adopt a short-term maximizing strategy and sell only Regulars. Buyers seeing only Regulars delivered will develop rational expectations and behave as if they expect only Regulars. Application of the laws of supply and demand yields predictions of all Regulars at a price P_R (*see* Table 1).

D. *Signaling Models*

If firms have a means of adding some distinguishable feature to units, that feature can sometimes be used as a signal that distinguishes offers of Supers from offers of Regulars. If the cost of adding this feature is sufficiently lower for Super units as opposed to the cost of adding the feature to Regular units, then signaling models predict a *signaling equilibrium*. The feature will be added to Supers only, and its presence will serve as a signal that lets buyers differentiate the underlying grades of units. *See* Spence (1977), Rothschild and Stiglitz (1976), Miller and Plott (1983).

Signaling models have an obvious application when warranty instruments exist. If warranties exist and are costlessly enforced, the cost of adding a warranty of Super to a Super unit is zero and the cost of adding a warranty of Super to Regular units is the difference between the cost of providing a Super and the cost of providing a Regular. The warranty guarantees specific performance, so a seller advertising a Super must deliver one and therefore loses the cost advantage of delivering a Regular. If warranties are required or are optional, then the signaling model becomes the full information model and therefore has the same predictions. The results will be volume that is all Super units sold with a warranty[8] and the price will be P_S (*see* Table 1).

[8] Grossman (1981) develops the notion that the warranty will be added. His model differs from the signaling model, but in this narrow case the predictions are the same.

A model developed by Grossman (1981) leads to the same conclusions (Leland, 1981), but the Grossman model is based on different principles. Grossman applies a perfect equilibria principle from game theory[9] and a rational expectations principle.[10]

If warranties are not enforced, then the cost differential between adding the special feature to Supers and to Regulars disappears. Regulars can be advertised as Supers. The signaling model then predicts that no separation will occur because Super units and Regular units will both add the special feature. Regular units will be offered along with an unenforceable warranty that the unit is a Super. Buyers will adopt expectations accordingly and anticipate that all units are regulars. The final result will be all Regulars at a price of P_R (*see* Table 1).

The lemons model can also be interpreted as a degenerate case of the signaling model. In Akerlof's (1970) model, price serves the dual role of equilibrating supply and demand and signaling the quality of the product sold. Because of the one shot nature of trades and the absence of any cost associated with signaling high quality with high price, price cannot effectively signal quality and therefore only lemons are traded.

E. *Reputation Models*

Models of reputation formation tend to be motivated by the theory of dynamic games. Buyers behave as if they are aware of seller identities and adopt dynamic strategies of rewarding and punishing sellers. Sellers who perform as the buyer desires are rewarded with future business, and sellers who do not perform are avoided. Sellers recognize buyer behavior in developing their own dynamic strategies.

A model developed by Klein and Leffler (1981) postulated a *quality guaranteeing price (weak version)*. Buyers who observe a Regular delivered on terms that buyers would ordinarily expect a Super act as if that seller will always deliver Regulars in the future. A seller who has once "fooled" buyers will sell only Regulars at P_R (*see* Table 1). If sellers anticipate this buyer reaction and if sellers expect one full period more in the market, then, given the parameters in these markets, sellers have an incentive to deliver Supers at any price above P_S - 10. Rational expectations and the law of supply and demand yield a model that predicts only Supers will be sold in the market and these will be delivered at a price of P_S. As the end of the experiment approaches, sellers will sell Regulars at P_S and thereafter sell Regulars at P_R.

A natural extension of the theory to a *quality guaranteeing price (strong version)* can be applied even when buyers do not know seller identities. Buyers, once seeing a regular delivered to the market in the "high" price range, will anticipate that all future deliveries will be regulars. The resulting demand function will be that for Regulars. Price will immediately fall to the regular com-

[9] The principle is imbedded in equations (A4) and (A5) on page 481, Grossman (1981).

[10] Statement (A6) on page 481, Grossman (1981).

petitive equilibrium. Sellers know that a single regular sale will "spoil" the market for all. Thus, if the price is high enough, sellers will sell only supers.

Other reputation models can be found in the literature (Rogerson 1982; Shapiro 1982a,c; Nelson 1974; Schmalensee 1978). The thrust of these models is that sellers who feel that buyers can tailor their reactions to individual sellers by refusing to buy from them or by paying a premium to certain sellers will in turn modify their behavior in anticipation. According to the model, buyers will patronize sellers who have a history of offering good grades and sellers will respond by offering good grades. The result in the parameters of our experimental markets will be that only Supers will be sold. Premiums, prices above P_s, might be paid to sellers who consistently sell Supers.

IV. Results

The time series of all markets are in Figures 2 through 22. Each contract is shown according to price and the ordinal time at which it occurred. Market efficiencies, summary statistics for each period, and the regime of treatment variables is also shown. Tables 2, 3 and 4 show average efficiencies for various periods under each regime.[11] Comparisons of efficiency between different periods or regimes should be made cautiously because the periods may have occurred at different stages in a given market, there may be a different number of periods in the intervals compared, etc. In spite of these difficulties, the reader may find the tables useful in gaining an overview of our results.

Conclusion 1. When disclosures (if made) must be truthful, the full information model works well.

Argument. The relevant markets (periods) are shown in Table 3. The full information model predicts all Super units, 100 percent efficiency and prices equal to P_s in Table 1. Of the 308 units sold during the relevant periods, 275 (89 percent) were Supers. On eight occasions an enforced warranty was imposed after the market had previously been operating under an alternative regulation and in all eight cases efficiency increased immediately. In three cases truthful disclosure was removed and in all three cases efficiency fell immediately. The absolute levels of efficiency are "near" the predicted 100 percent by the second period of enforced warranties. More precisely, the levels are above 90 percent in seven of seven second periods and at 100 percent in three of the seven. By the second period of enforced warranties prices in all cases are within 10 francs of the price predicted by the full information model. Average efficiency for all periods was above 95%.

[11] We are indebted to Richard Craswell for suggesting the classification scheme embodied in Tables 2-4. Market efficiency as developed by Plott and Smith (1978) refers to actual earnings as a percentage of the maximum possible earnings.

Figure 2: Experiment 1

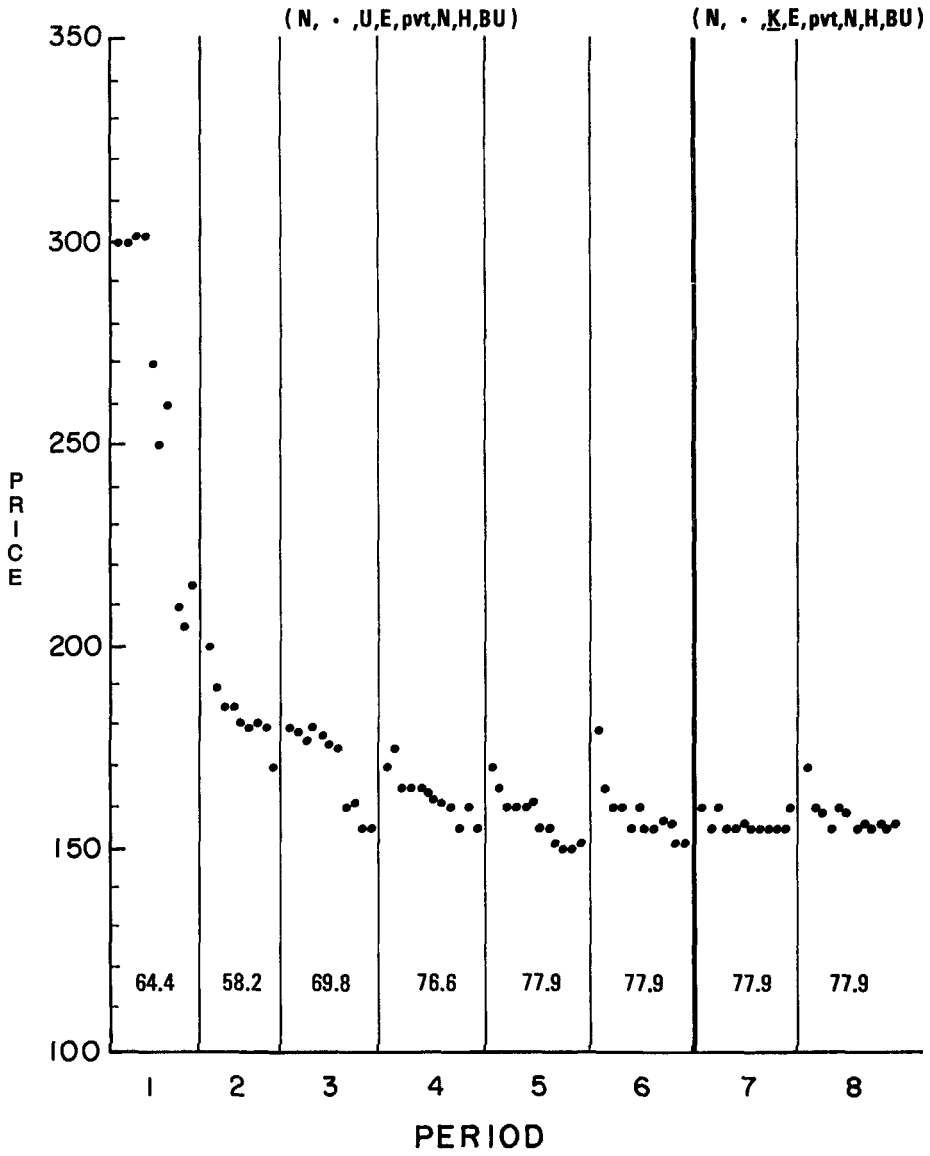

Figure 3: Experiment 2

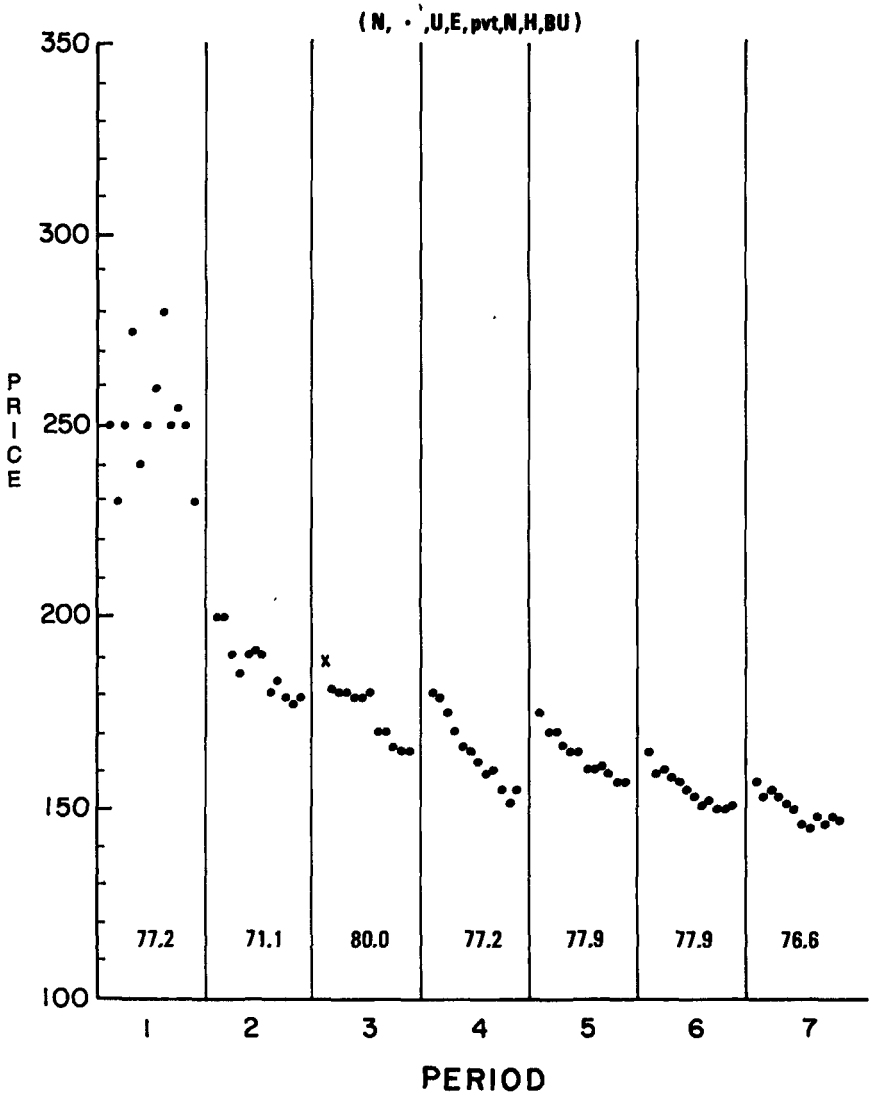

Figure 4: Experiment 3

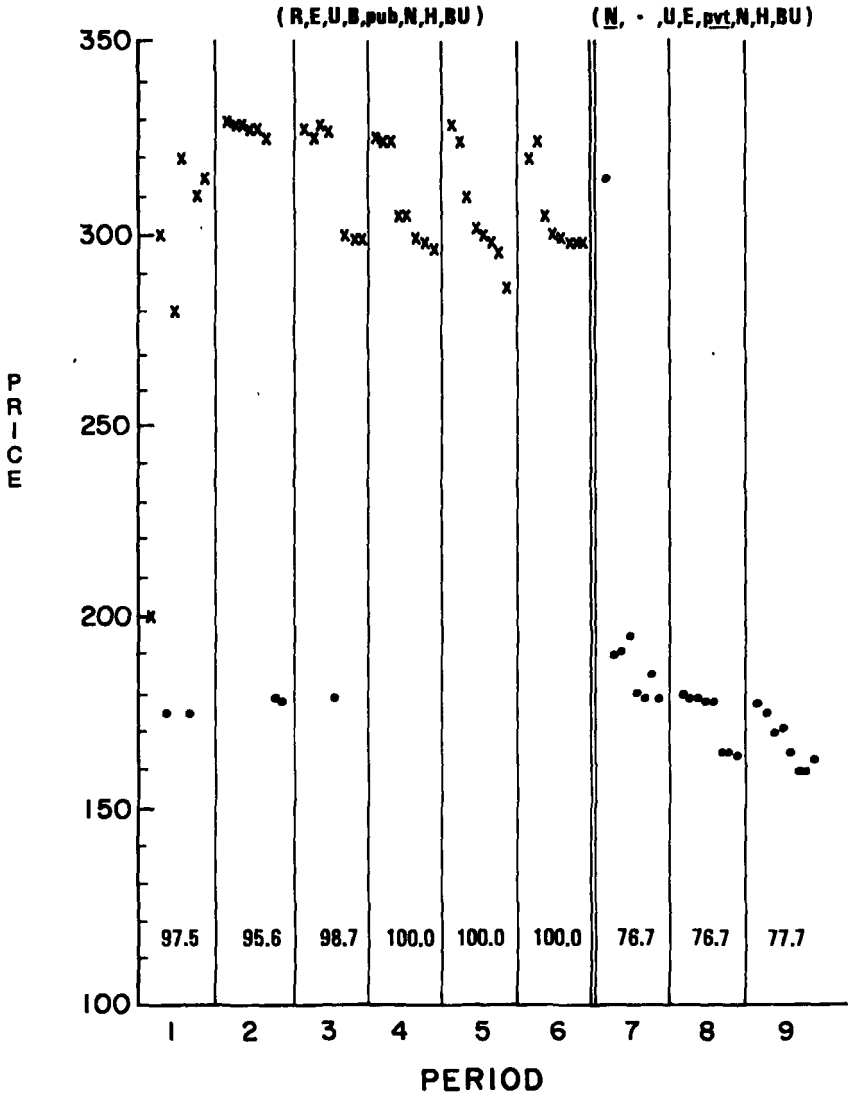

Figure 5: Experiment 4

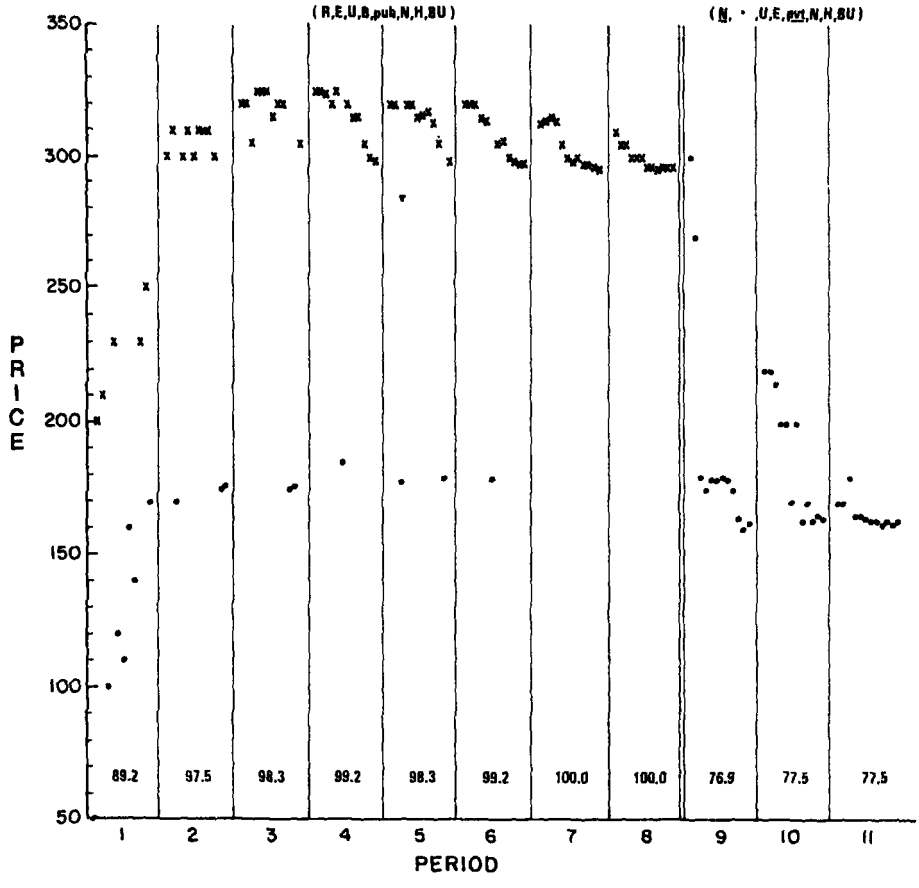

Figure 6: Experiment 5

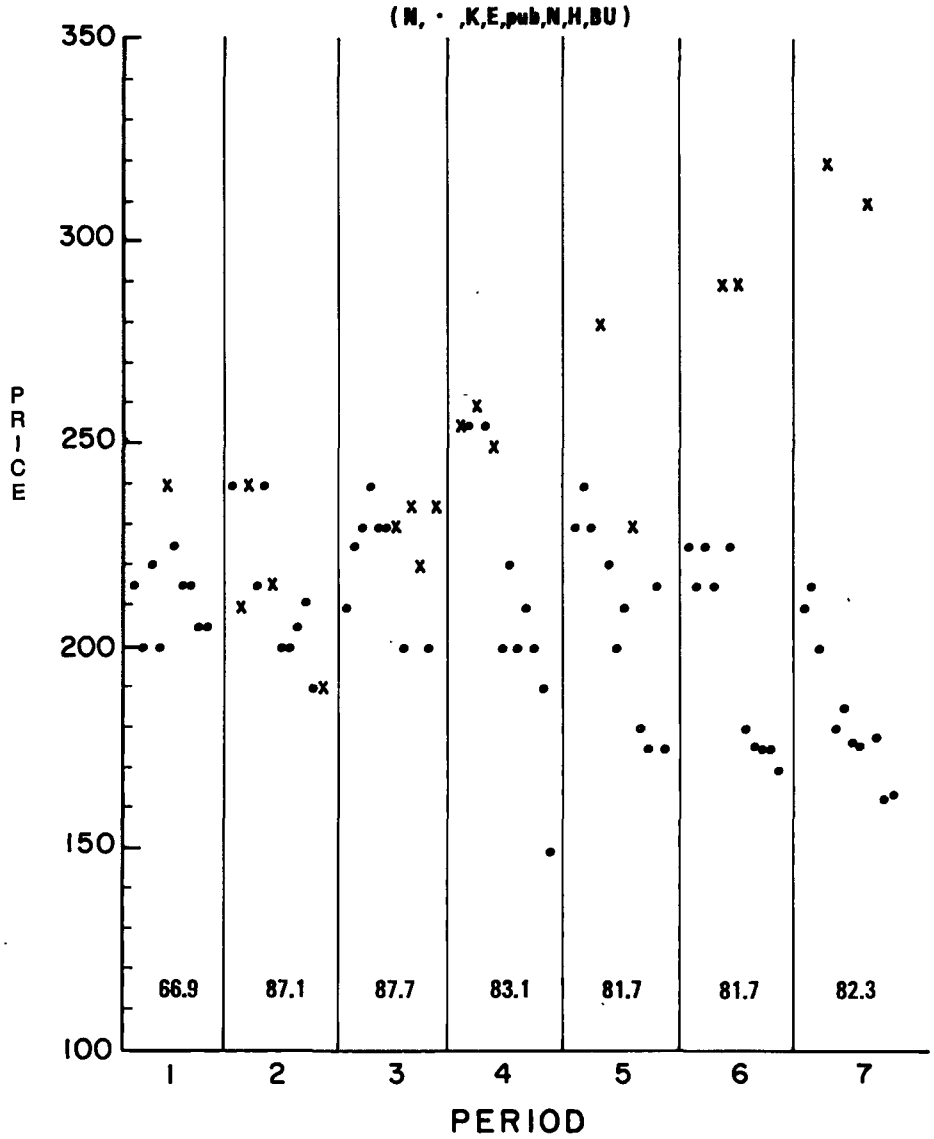

Figure 7: Experiment 6

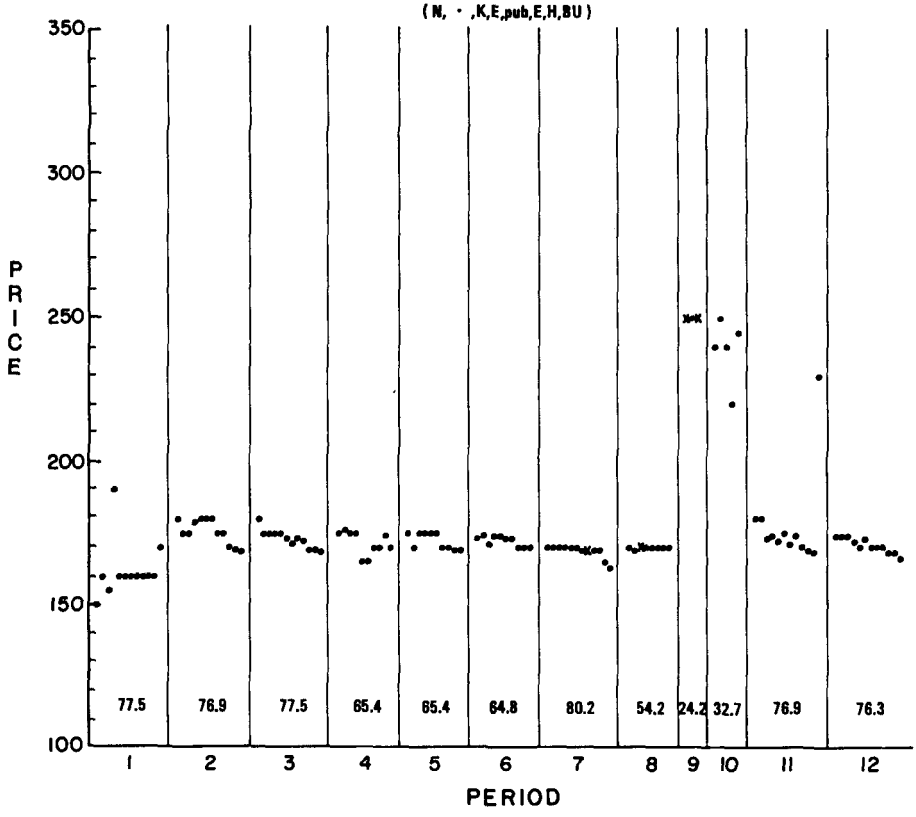

Figure 8: Experiment 7

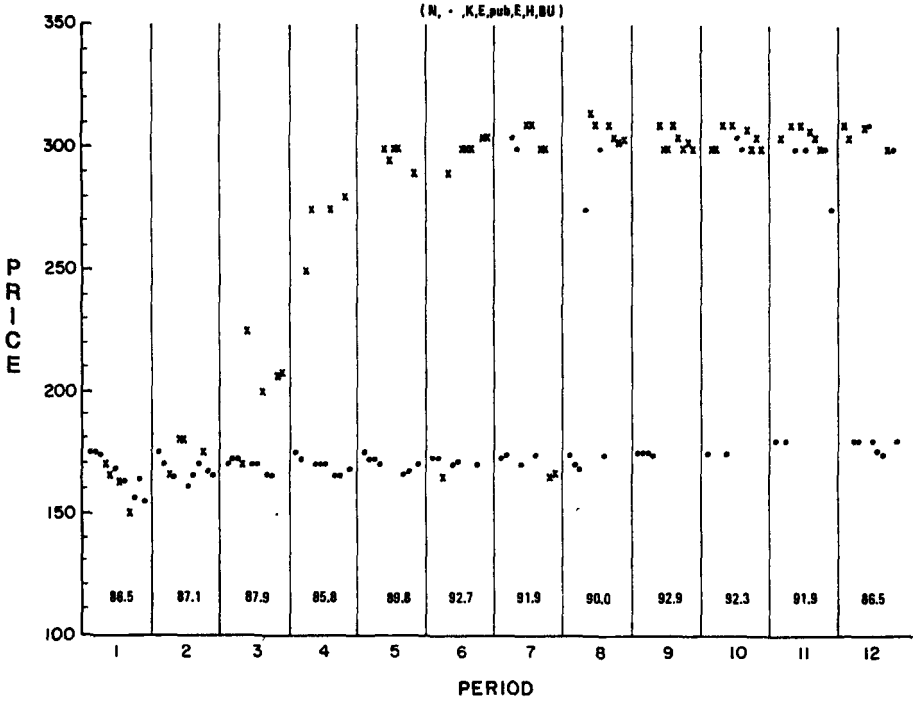

Figure 9: Experiment 8

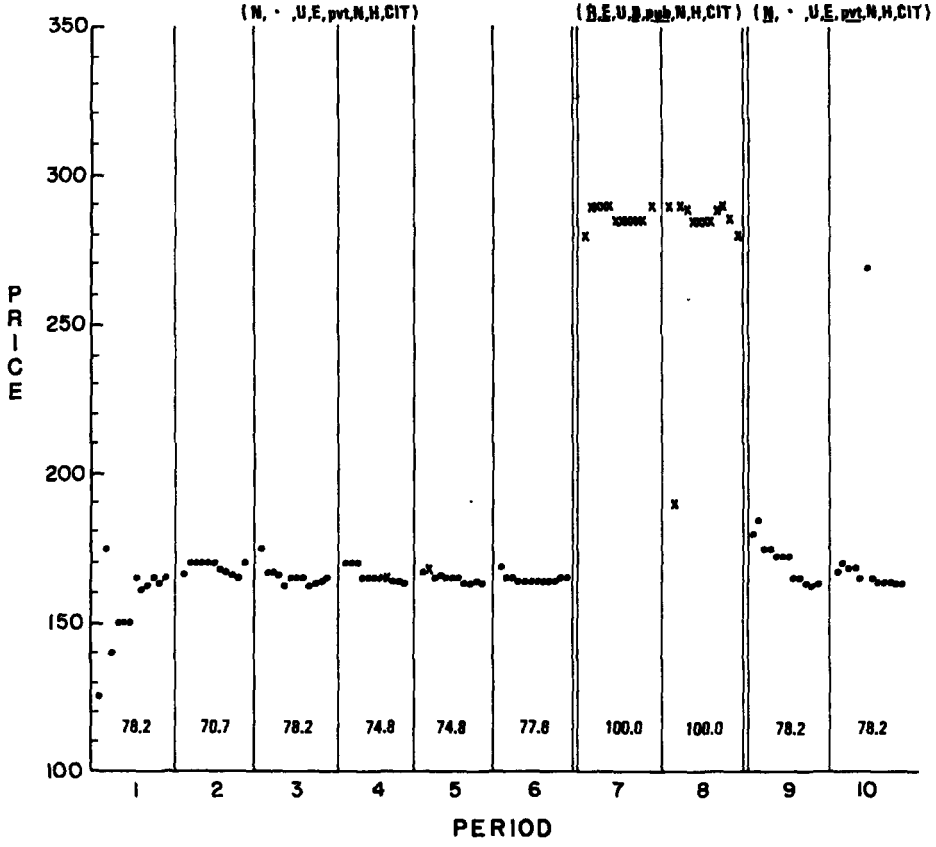

Figure 10: Experiment 9

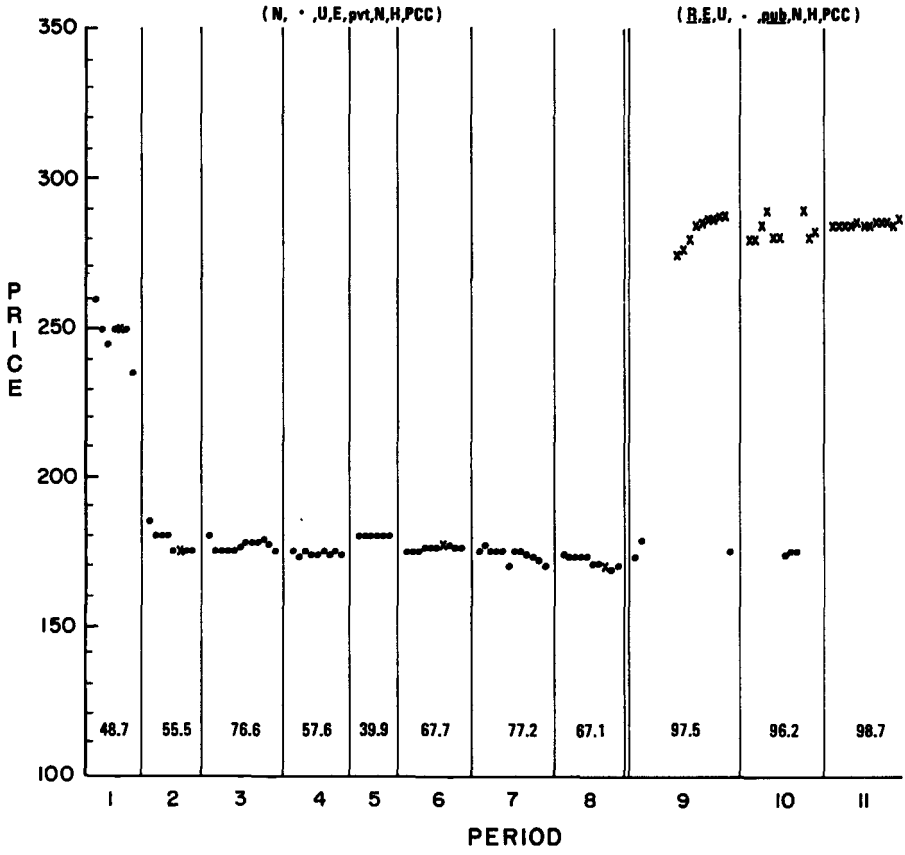

Figure 11: Experiment 10

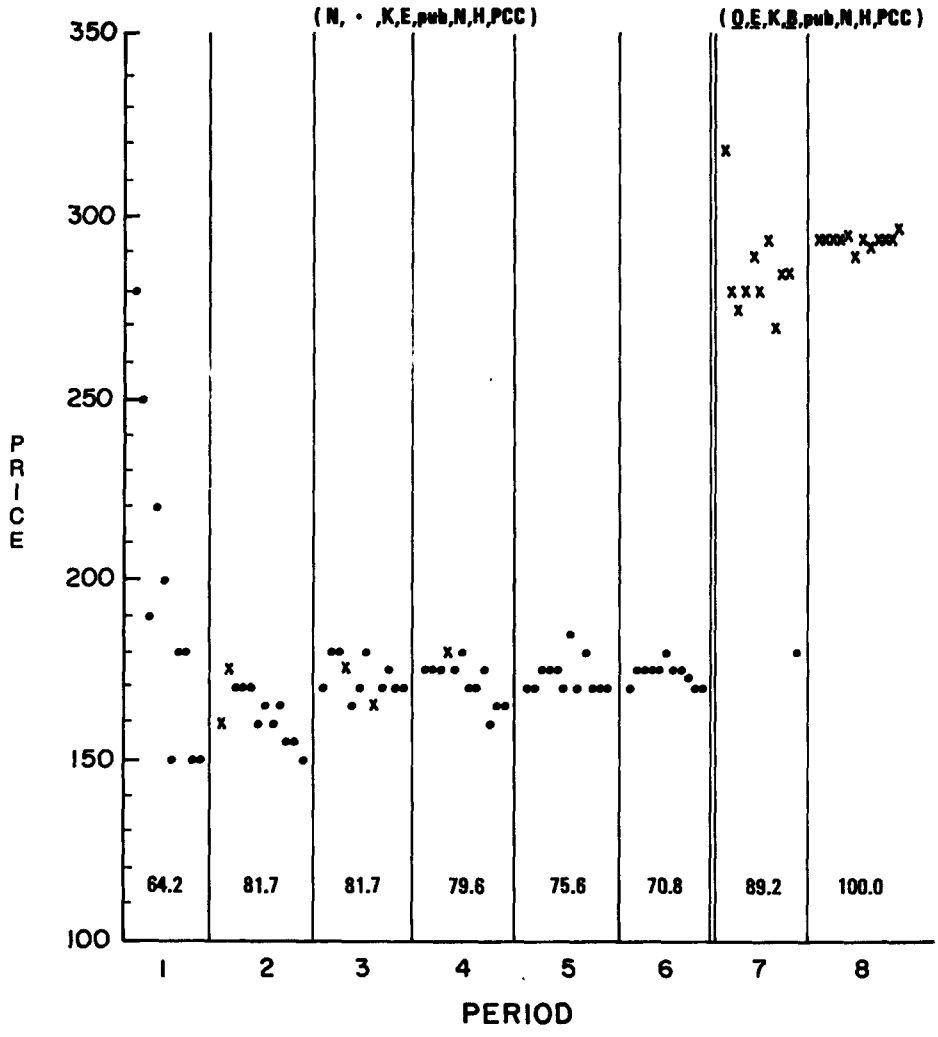

Figure 12: Experiment 11

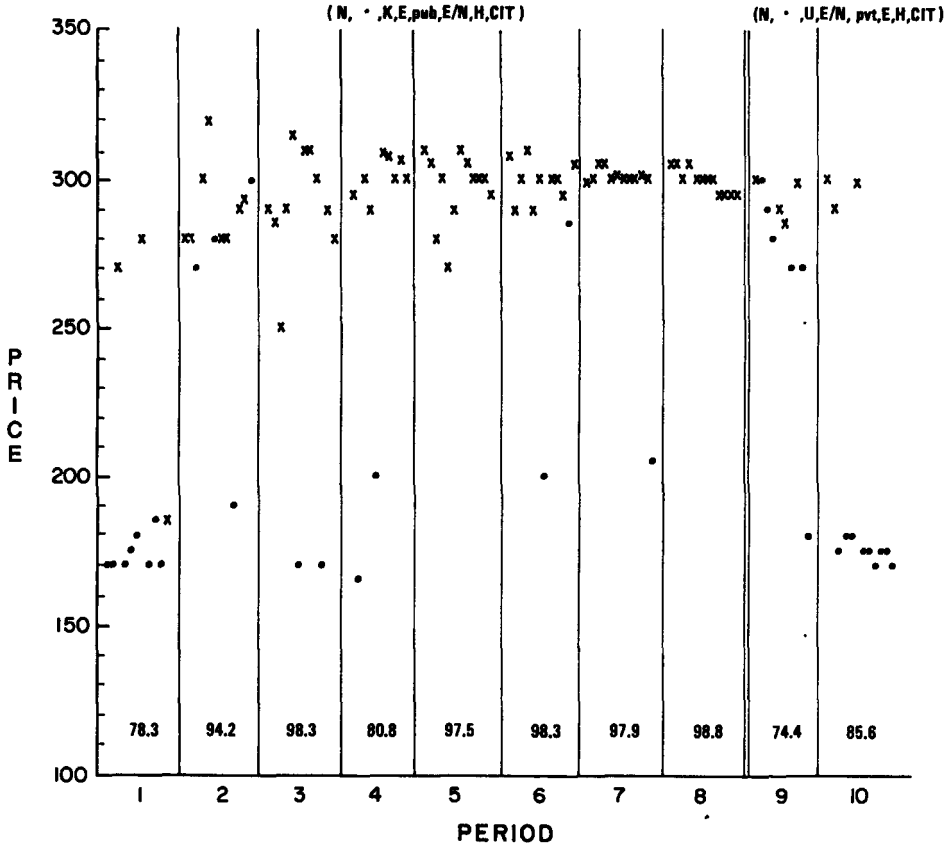

Figure 13: Experiment 12

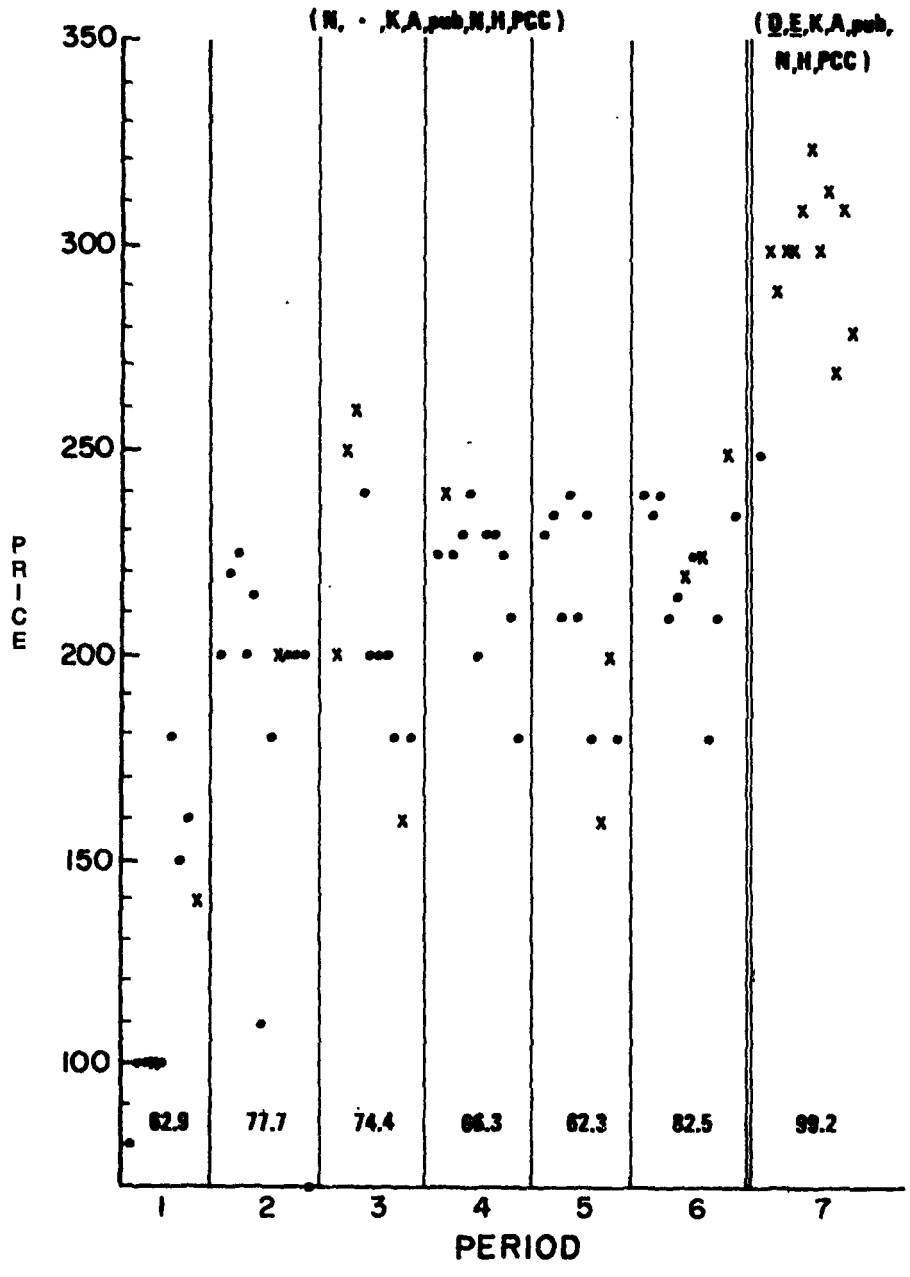

Figure 14: Experiment 13

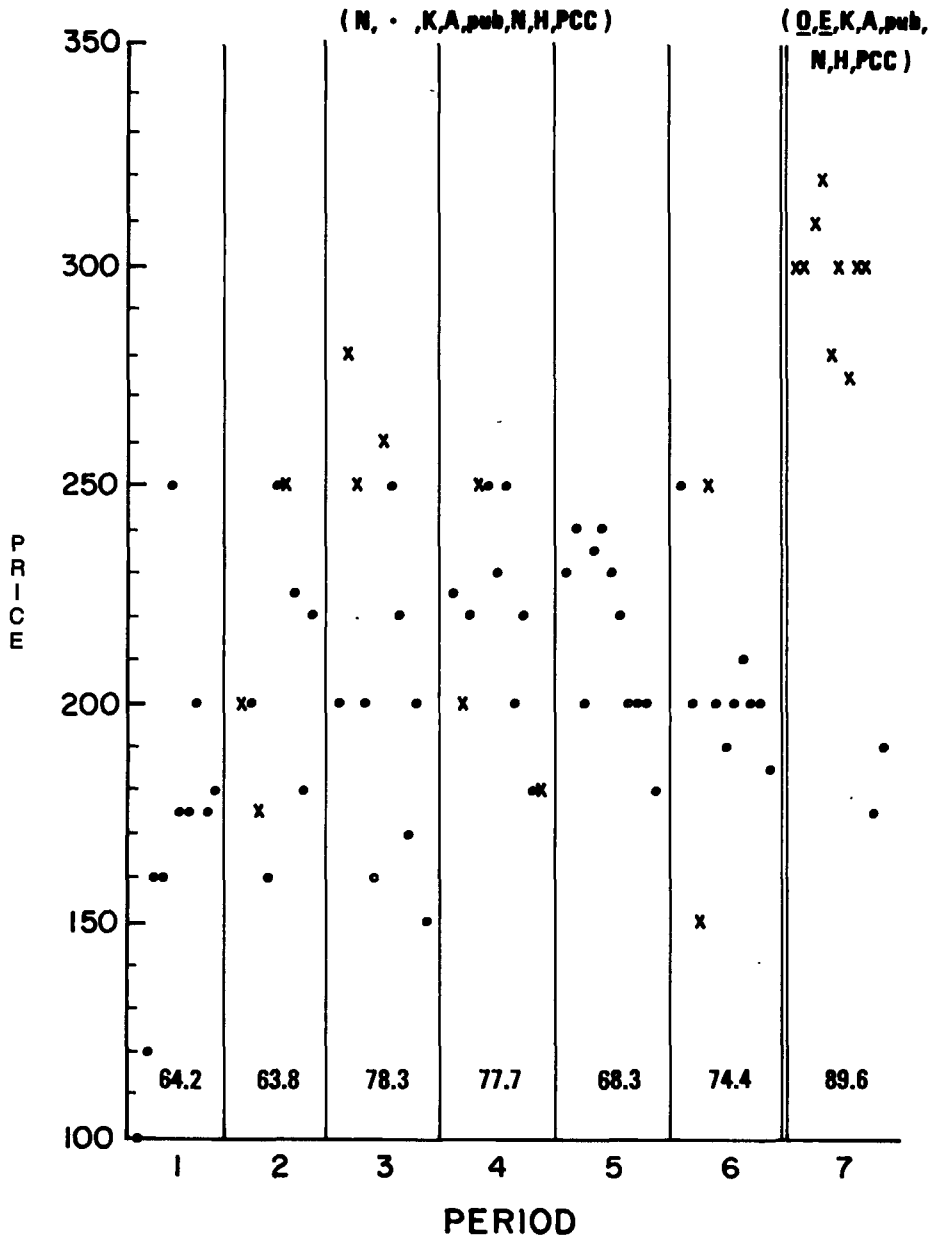

Figure 15: Experiment 14

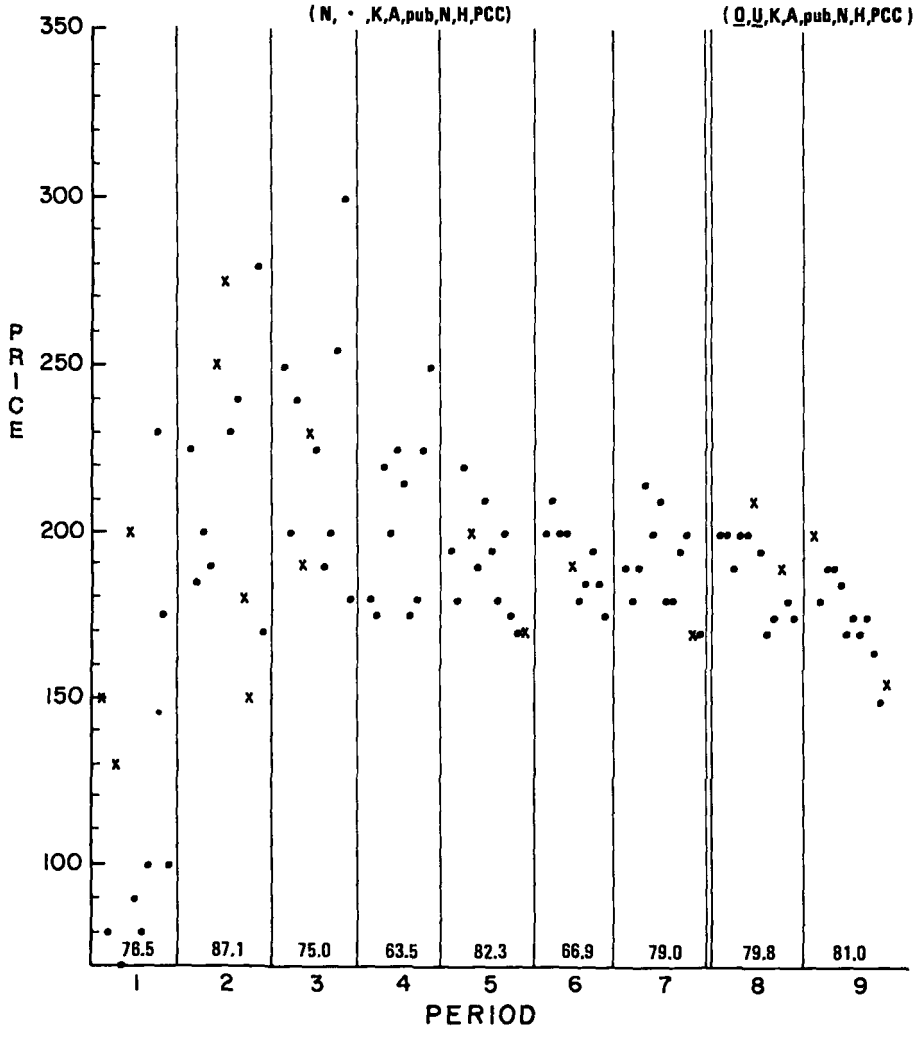

Figure 16: Experiment 15

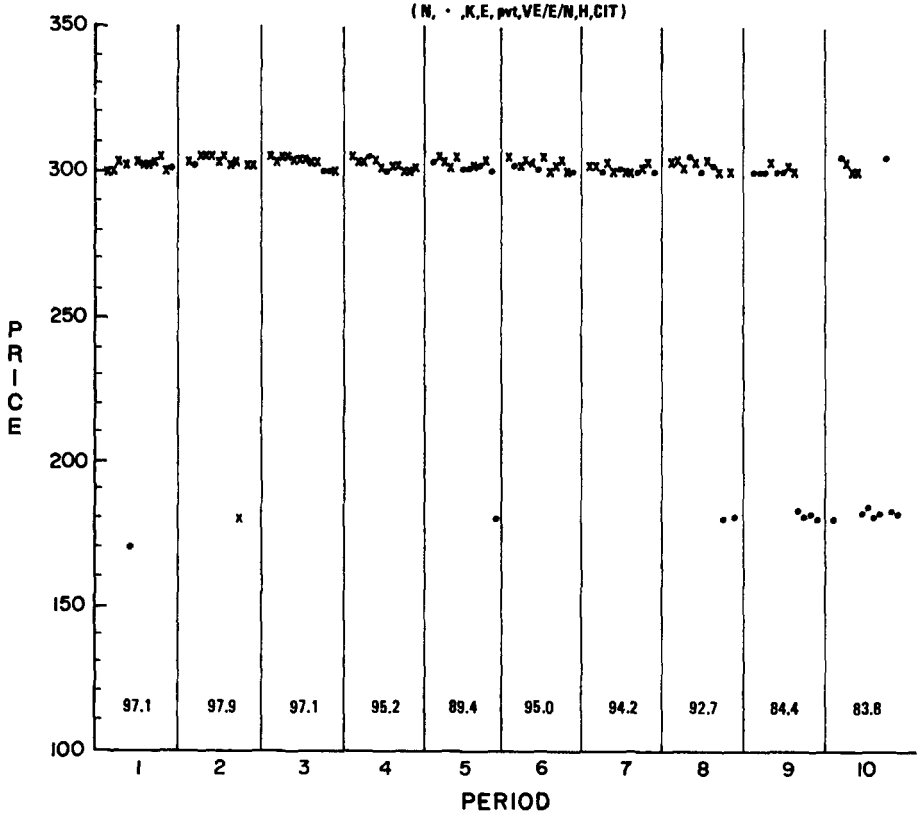

Figure 17: Experiment 16

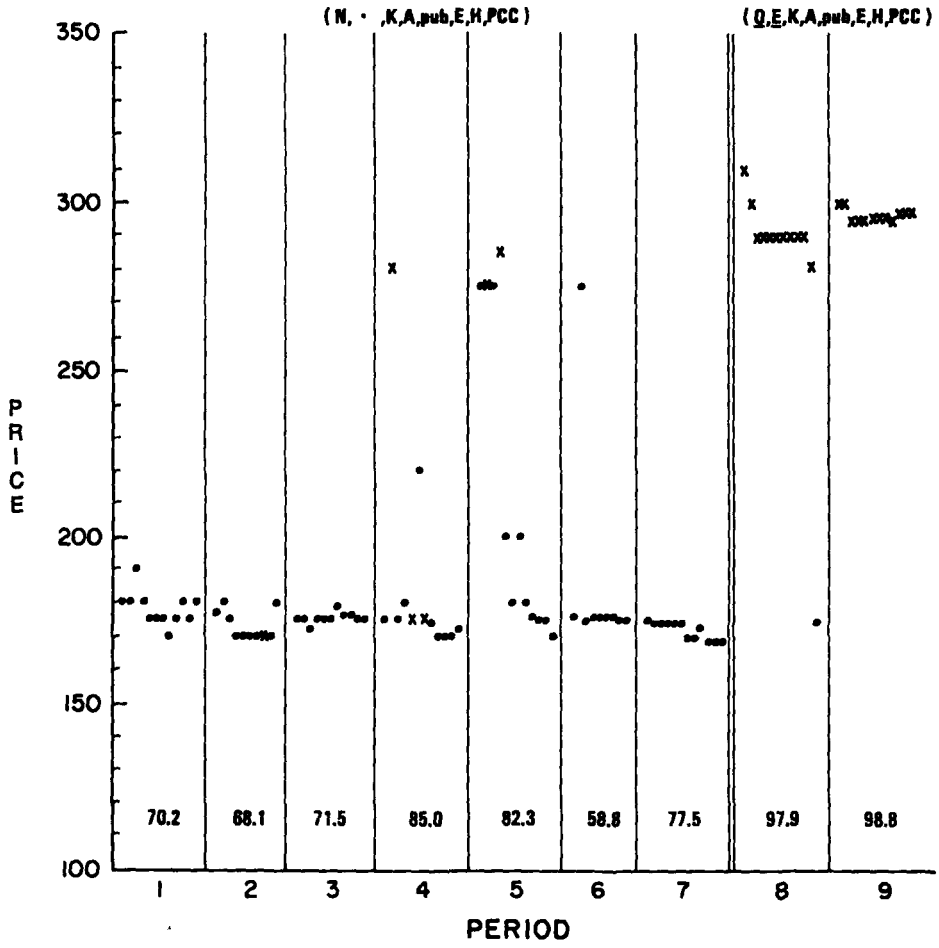

Figure 18: Experiment 17

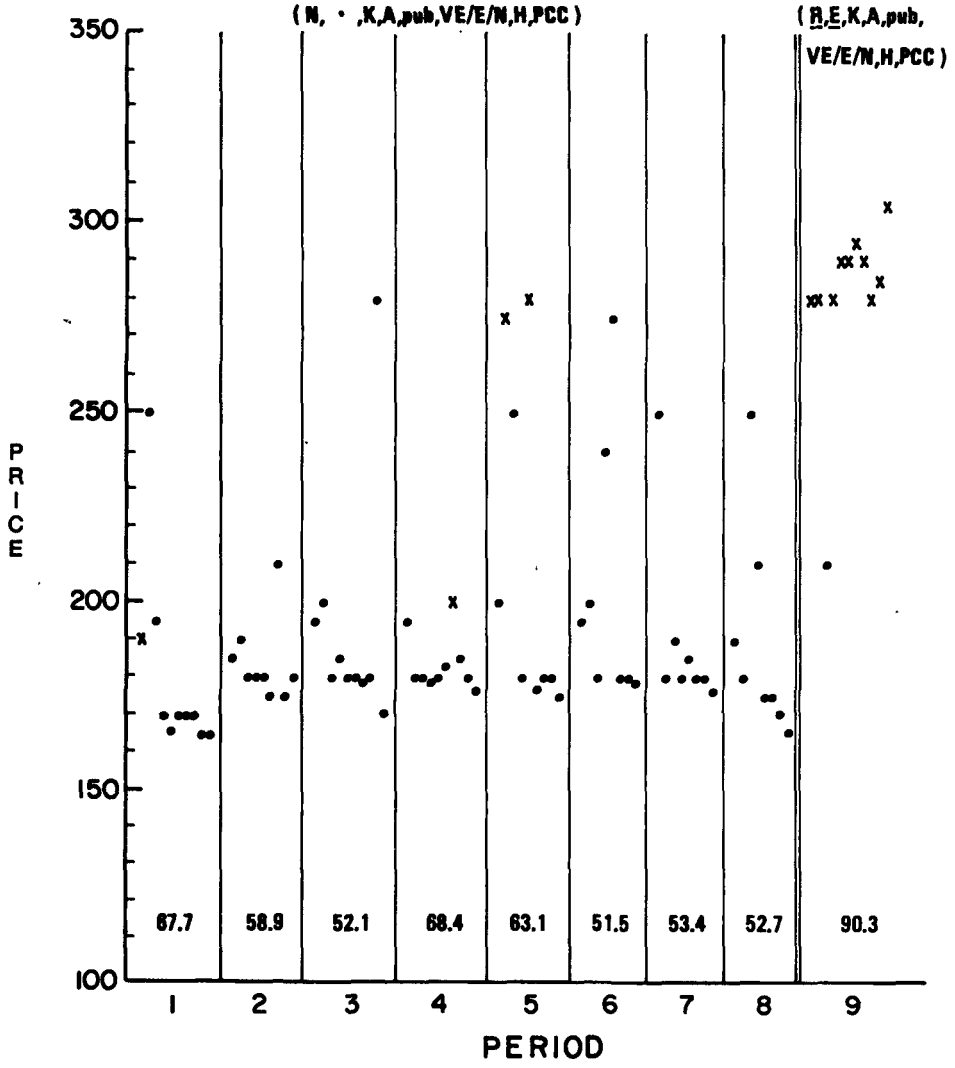

Figure 19: Experiment 18

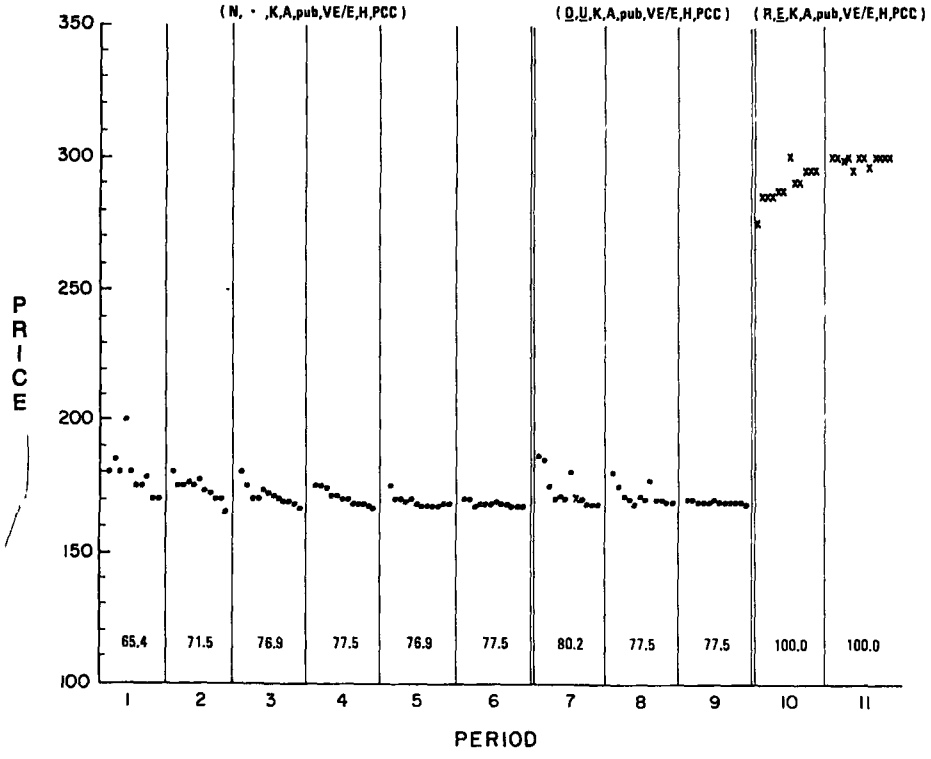

Figure 20: Experiment 19

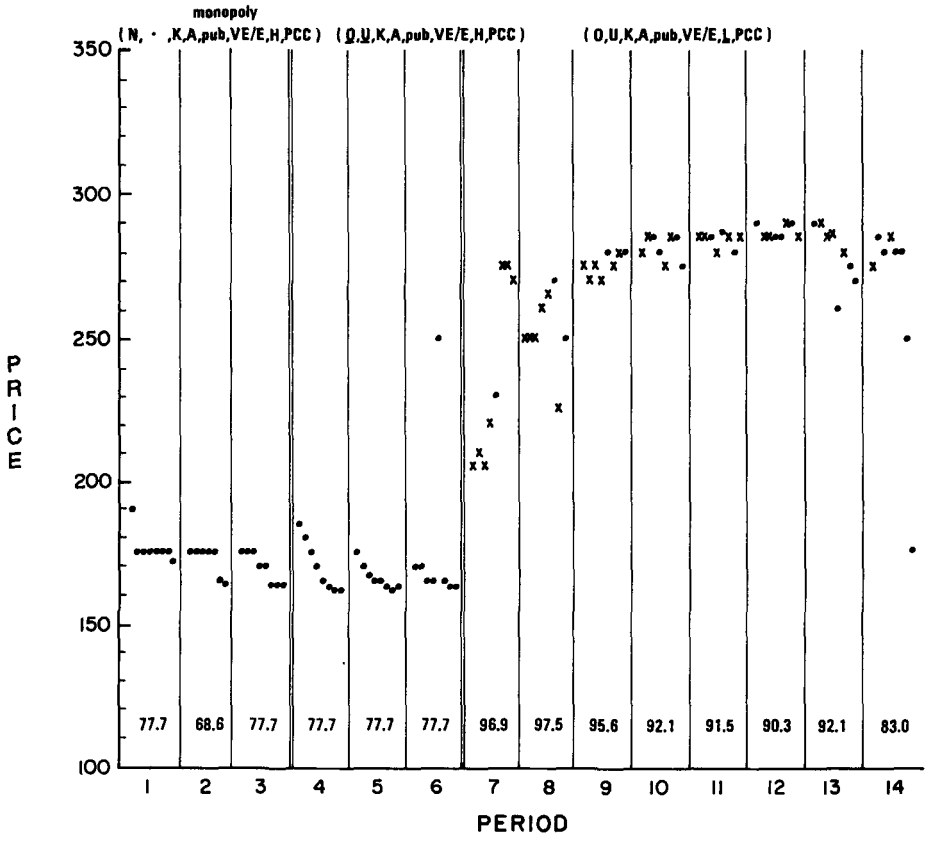

Figure 21: Experiment 20

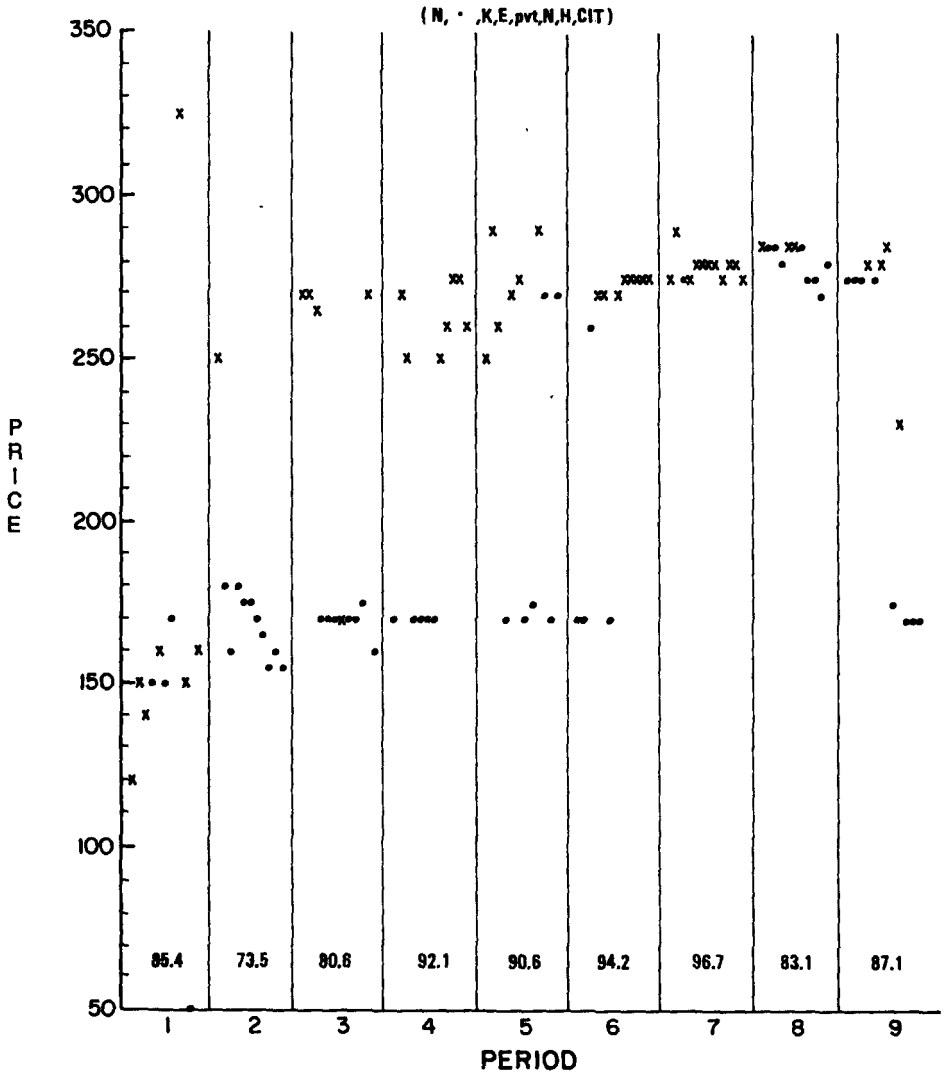

Figure 22: Experiment 21

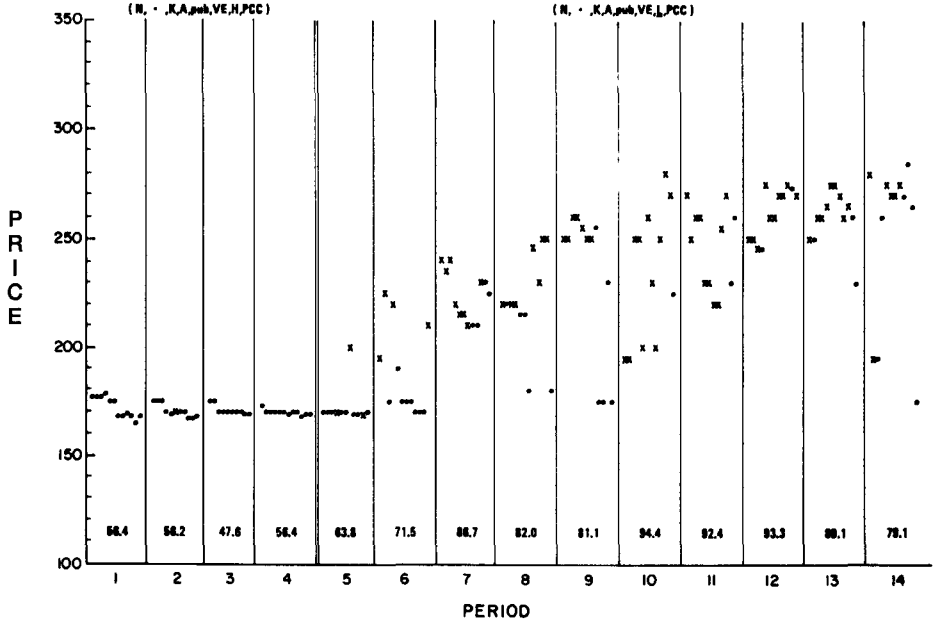

Table 2

EFFICIENCY IN MARKETS WHERE DISCLOSURES ARE PROHIBITED

	Seller ID Known			Seller ID Unknown		
	Experiment &Periods	School	Efficiency	Experiment &Periods	School	Efficiency
Buyers Have:						
	1:(7,8)	BU	78%	1:(1-6)	BU	71%
	15:(1-10)	CIT	93%	2:(1-7)	BU	77%
Private	20:(1-9)	CIT	87%	3:(7-9)	BU	77%
Information	Average	CIT	90%	4:(9-11)	BU	77%
Only	Average	All	89%	8:(1-6,9,10)	CIT	76%
				9:(1-8)	PCC	61%
				11:(9,10)	CIT	80%
				Average	BU	75%
				Average	CIT	77%
				Average	PCC	61%
					All	72%
	5:(1-7)	BU	82%			
	6:(1-12)	BU	64%			
	7:(1-12)	BU	90%			
	10:(1-6)	PCC	76%			
	11:(1-8)	CIT	93%			
	12:(1-6)	PCC	71%			
Public	13:(1-6)	PCC	71%	NOTE: An all Regulars "Lemons"		
Information	14:(1-7)	PCC	76%	Equilibrium is 78% of the		
	16:(1-7)	PCC	73%	Maximum Possible Surplus		
	17:(1-8)	PCC	58%			
	18:(1-6)	PCC	74%			
	19:(1-3)	PCC	75%			
	21:(1-4)	PCC	73%			
	21:(5-14)	PCC	83%			
	Average	BU	78%			
	Average	CIT	93%			
	Average*	PCC	71%			
	Average*	All	75%			

*Excludes 21:(5-14), periods with low cost supers. For these periods a "lemons" equilibrium is only 56% of maximum surplus.

Table 3

EFFICIENCIES IN MARKETS WHERE TRUTHFUL DISCLOSURES ARE PERMITTED

Advertising (or Labeling or Warranty Provision)

Advertising (Labeling, or Warranty Provision)	Must Be Truthful					
	Seller Known			Seller Unknown		
	Experiments & Periods	School	Efficiency	Experiments & Periods	School	Efficiency
Is Required	17:(9)	PCC	90%	3(1-6)	BU	99%
	18:(10-11)	PCC	100%	4:(1-8)	BU	98%
				8:(7,8)	CIT	100%
				9:(9-11)	PCC	97%
	Average	All	97%		All	98%
Is Optional	10:(7,8)	PCC	95%	NOTE: An all Regulars "Lemons" Equilibrium is 78% efficient		
	12:(7)	PCC	99%			
	13:(7)	PCC	90%			
	16:(8,9)	PCC	98%			
	Average	All	96%	NOTE: Public Information in all periods.		

Table 4

EFFICIENCIES IN MARKETS WHERE DISCLOSURES ARE PERMITTED AND MAY BE FALSE

Advertising (or Labeling, Warranty Provision	Seller Known			Seller Unknown	
	Experiment & Periods	School	Efficiency	Experiment & Periods	School
Is Required	None			None	
Is OPTIONAL	14:(8,9)	PCC	80%	NONE	
	18:(7-9)	PCC	78%		
	19:(4-6)	PCC	78%		
	19:(7-14)	PCC	83%		
	Average*	All	79%		

*Average excludes 19:(7-14), *i.e.*, those periods where the cost of supers was reduced. For these periods the all regulars "lemons" equilibrium is only 56% of the maximum surplus.

Conclusion 2. The lemons model works well when seller identification is unknown and disclosures are prohibited.

Argument. The relevant markets (periods) are shown in the right hand columns of Table 2. The lemons model predicts that only regular units will be sold. Of the 399 units sold in the periods in which seller identification was unknown and warranties were unenforced 384 (96 percent) were regulars. Efficiency predicted by the lemons model is approximately 78 percent in all markets. In the next to last periods of the sequences listed above, the efficiencies are within 1 percent (relative to full efficiency) of the lemons equilibrium efficiency. Average actual prices are within 5 francs of the prices predicted by the lemons model by the fourth period of all markets except market 9 where they are from 10-15 francs too high and only slowly converging. Average efficiency for all relevant periods was actually less than the lemons equilibrium at 72%.

Conclusion 3. The Grossman/signaling hypothesis that enforceable warranties will be voluntarily added to units (or that if disclosures must be truthful sellers will voluntarily make them) is supported in the data.

Argument. The relevant periods are shown in the lower left hand corner of Table 3.[12] Of the 72 offers in the relevant periods, 53 indicated a Super, and of the 83 bids, 74 requested a Super. Of the 65 Supers sold, 64 were supported by an express warranty. Average efficiency is 96%, about the same as when disclosures are mandatory and truthful.

Conclusion 4. Sellers will nontruthfully advertise when it is possible. The "pooling" or regulars posing as supers phenomena predicted by the signaling models are observable when advertising need not be truthful (express warranties are not enforced).

Argument. The relevant periods are shown in the lower half of Table 4 in which advertising was optional but the implied express warranty was not enforceable. A total of 147 trades were made during these periods of which 105 were regulars and 42 were supers. A total of 61 of the regulars sold were falsely advertised as Supers (58 percent) with the other 44 advertised as Regulars or unadvertised. These misrepresentations are not random mistakes, because all of the 42 supers sold were also advertised as Supers. There were no "mistakes" at all.

Conclusion 5. Knowledge of seller indentification in the absence of truthful but voluntary disclosure:

i) does not guarantee efficiency improvements over the lemons" equilibrium, but in some markets such knowledge increased efficiency.

ii) can continue to have an influence if grade is only privately disclosed.

[12] Some ambiguity exists about whether or not warranties were optimal or were required in 17(9) and 18(10,11). Of the 43 offers in these periods, 37 indicated a Super, and of the 39 bids 36 requested a Super. All of the 34 Super sales were supported by a warranty.

Argument. The relevant markets (periods) for part i are given in the left half of Table 2 and the lower left half of Table 4. The relevant periods of experiments 1, 6, 10, 12, 13, 14, 16, 17, 18, 19(1-6), 21(1-4) have efficiency levels insignificantly above that of the lemons equilibrium. For the most part these efficiencies are close to the lemons model predictions, even though the price data suggest that buyers (especially inexperienced PCC buyers) are more optimistic than the lemons model suggests they would be. Experiment 5 is on the borderline but the relevant periods of 7, 11, 15, 19(7-14), 21(5-14) have efficiencies substantially above the lemons model values. In addition, these markets show evidence of improved efficiency over time. The data in parts of 15, 20, and 21 compare favorably with truthful disclosure markets.

Controlling for possible subject pool differences by comparing only experiments drawing from the same subject pool and in which seller identifications are known (for more than three periods) versus those in which they are unknown, the conclusion still emerges. Efficiencies in all but one of the nineteen periods of 5 and 7 are higher than the comparable experiments in the BU subject pool of 1 and 2. In the CIT pool, of the twenty-five periods of 11, 15, and 20 all but two are higher than the relevant periods of 8. Finally, in 11 efficiency goes down when seller I.D.'s are removed. The data in the PCC experiments are less clear unless the cost of Supers is lowered.

The relevant data for part ii come from the CIT markets 15 and 20 in comparison with 8 (upper half of Table 2). In all of these markets grade was only privately revealed. Efficiencies in all but two periods of 15 and 20 are higher than in all periods of 8. Average efficiency is about 90% for 15 and 20, compared to 76% for 8.

Conclusion 6. The signaling model works except where seller identification is known. Where seller identifications were known, the predictions of the model were less reliable and in some cases inaccurate relative to the full information model.

Argument. The signaling model predictions coincide with the full information model when warranties are enforceable and with the lemons model when warranties are not enforceable. Both predictions are supported. When warranties are optional but enforced, the signaling model predicts they will be used.

The predictions of the signaling model remain the same when seller identifications are known. In fact, the signaling model is basically a static model and, unless it is reinterpreted to designate "reputation" as a "signal," predicts that the market will be insensitive to the revelation of seller identification. Conclusion 4 demonstrates that the model fails at this point.

Conclusion 7. Buyer reaction to "ripoffs" is not that postulated by either the strong or weak versions of the quality guaranteeing price model.

Argument. The reaction postulated by the model has buyers boycotting sellers who deliver Regulars at a price that is unprofitable for buyers. Buyers necessarily

lose money on any purchase of a regular at a price of 180 or more. Consider all experiments where unenforceable warranties existed, seller identifications were known, and there was public revelation of grade. On 25 occasions sellers delivered a Regular at a price above 180 and were then able to make the very next sale at a price above 180. In 10 instances a seller sold a Regular to a buyer at a price above 180 and then sold to the same buyer within the next period at a price above 180 and without delivering a Super during the intervening time. The models predict that this will never occur.

Conclusion 8. A seller's demand depends not only upon his/her own "reputation" for delivering Supers, but also upon the market 'reputation." The Shapiro model (1982a), if it is to be generalized to multiple firms, must be changed to add a "market reputation" term.

Argument. The following model was estimated.

$$P_{iT} = C_1 + C_2 \cdot \sum_{t=1}^{T-1} (S_{i,T-t} \cdot A^{t-1}) + C_3 \sum_{t=1}^{T-1} (S_{.,T-t} \cdot B^{t-1})$$

$$S_{.,T-t} = \sum_{i=1}^{N} Si,t\text{-}t$$

P_{iT} = price received by seller i in period T

N = number of sellers

C_k,A,B = constants to be estimated

$S_{i,T-t}$ = number of Supers sold by seller i in period T - t so

$\sum_{t=1}^{T-1} (S_{i,T-t} \cdot A^{t-1})$ is *own reputation* = a weighted sum of all past Super sales by i.

$S_{.,T-t}$ = number of Supers sold in the entire market in the period T - t, so $\sum^{T-1} (S_{.,T-t} \cdot B^{t-1})$ is a *market reputation* = a weighted sum of all past Super sales.

The estimated coefficients are in Table 5. Data from experiments 19 (monopoly) and 21 (low cost Supers) were not included. The conclusion stated above is supported by the fact that five of the twelve experiments have a significant C_3 term.

Conclusion 9. The markets where individual sellers prices are not influenced by either their own reputation for selling Supers or the market reputation for Super sales do not exhibit either lemons behavior or full information behavior. Furthermore, significant influence of individual seller's own reputation on own prices is not a sufficient condition for reputation-induced efficiency gains.

Argument. In markets 12 and 13 neither C_2 nor C_3 is significant. Market behavior is not captured well by either of the two models. Both experiments 16 and 17 exhibited sensitivity to individual reputations, but neither exhibited substantial efficiency gains.

The A and B parameters measure the "discount" rate over time—whether past or most current Supers sales are most important. Those experiments for which A is small and C_2 significant suggest the importance is on the most recent individual behavior. Where B is small and C_3 is significant, the most recent market behavior seems to be the most important.

Conclusion 10. A reduction of buyer information about the grade deliveries of individual sellers from public information to private information decreases market efficiency.

Argument. Because of subject pool differences in market behavior, the only opportunity to reject the proposition occurred in the CIT experiments (left half of Table 2). Because efficiencies at both BU and PCC tended to be low, little opportunity existed for further efficiency losses. The public revelation of individual seller's decisions in market 11(1-8) at CIT produced efficiencies at near the 100 percent level. Efficiencies in experiment 11 (with public information and after period 4) dominate the efficiencies (after period 4) in both 15(1-10) and 20(1-9), where only private revelation of grade existed. The pattern of trades in the two private revelation markets is that suggested by the theory. Define a "ripoff" as a contract in which the price indicates that the (risk neutral) buyer was at least 90 percent confident that the unit would be a Super (270F), but a regular was delivered. In this case a Regular is delivered at a price of 270 francs or more. In market 11 a total of four ripoffs occurred while twenty-eight and fifteen ripoffs occurred in markets 15 and 20 respectively. While no tests are provided, both prices and efficiencies appear to be drifting downward in 15 and 20 and upward in 11.

Conclusion 11. A subject pool difference exists and subject experience makes a difference in market behavior.

Argument. The best example is between CIT 11 and PCC 16 and 17. These experiments had experienced participants, yet the market behavior of the PCC

Table 5

REGRESSION RESULTS

SELLER PRICE AS A FUNCTION OF OWN REPUTATION AND MARKET REPUTATION

EXP	C_1	C_2	A	C_3	B
5	215.16	13.16	0.958	-1.34	1.257
(N=72)	(34.50)**	(4.62)**	(7.232)**	(1.45)	(4.503)**
6	170.15	5.44	0.101	26.01	0.220
(N=106)	(109.23)*	(0.74)	(0.083)	(8.40)**	(2.955)
7	72.54	37.58	0.72	15.37	0.300
(N=136)	(5.53)**	(6.22)**	(0.499)	(4.33)**	(2.278)
10	164.39	0.07	3.675	2.62	0.741
(N=59)	(103.99)**	(0.13)	(0.383)	(3.42)**	(4.964)**
11	283.49	13.46	0.547	-3.75	-0.741
(N=82)	(22.93)**	(2.46)**	(3.041)**	(1.78)	(0.173)
12	185.81	-1.85	1.314	3.34	1.093
(N=55)	(13.66)**	(0.29)	(0.729)	(1.09)	(2.714)**
13	205.35	-7.48	-0.221	2.55	0.145
(N=53)	(16.51)	(1.01)	(0.211)	(0.84)	(0.147)
14	186.97	-0.61	-1.318	5.37	0.205
(N=67)	(13.74)**	(0.14)	(0.555)	(2.25)*	(0.482)
15	206.92	22.36	0.367	4.55	-0.200
(N=108)	(11.71)**	(3.48)**	(2.190)*	(2.12)*	(-0.760)
16	177.87	23.17	-0.501	1.81	-0.023
(N=66)	(28.57)**	(2.79)**	(1.185)	(0.75)	(0.012)
17	191.21	38.97	-0.200	-2.02	-0.600
(N=62)	(47.70)**	(5.04)**	(0.955)	(0.63)	(0.501)
20	162.78	17.37	-0.054	3.79	0.728
(N=94)	(10.82)**	(2.46)**	(0.132)	(1.65)	(3.346)**

Numbers in parentheses are t-statistics.

* significant at .95 level

** significant at .99 level

group is lemons, while the behavior of CIT is full information. Again an interesting comparison exists between the inexperienced PCC participants of 12, 13, and 14, which is difficult to describe in terms other than overly optimistic buyers, with the behavior of 20, which used inexperienced CIT participants. Notice, however, that with some institutional arrangements, such as markets with unknown sellers and markets in which express warranties were enforced, the differences between subject pools is almost nonexistent.

Experience seems to be important in the PCC subject pool when seller identifications are known, and enforced warranties are absent. Compare 12, 13, and 14 with 16, 17, 18, 21. The purchases that can be characterized as made by overly optimistic buyers substantially disappear with experience. In brief, the models seem to work better as participant experience increases.

Conclusion 12. The time of revelation, whether revelation was made at the end of the period or immediately after the sale, made no difference.

Argument. Markets 5(BU) and 10(PCC) had inexperienced subjects and the revelation came at the end of a period. Markets 12(PCC), 13(PCC), 14(PCC) had inexperienced subjects and the revelation was made immediately after a sale. Market efficiencies are indistinguishable.

Experienced participants in 6(BU), 7(BU) with revelation at the end of the period can be compared to participants in 16(PCC), 17(PCC), 18(PCC) and 21(PCC) when revelation was made immediately after sale. Market 7 with the credence property had the highest efficiencies. The others are indistinguishable.

Conclusion 13. A reduction in the relative cost of Supers switched market behavior from that of the lemons model to that of the full information model.

Argument. On two occasions the relative cost of Supers was lowered, markets 19(7-14) and 21(5-14). Prior to the lowering of cost the markets were essentially at a lemons equilibrium. After the cost was lowered the number of Supers delivered increased significantly as did efficiencies and prices.

Conclusion 14. Aside from a possible small increase in price at first, nontruthful advertising had no effect on average price.

Argument. Two of the three cases, in which warranties were optional but unenforced, experienced a slight upward movement in price at first, 18(7), 19(4), but prices then returned to previous levels. The third case, 14(8) experienced no upward movement at all.

V. Summary and Interpretation of Results

The lemons phenomena can occur (conclusion 2). We are aware of no other clear documentation of its existence. Markets will not necessarily allocate information to the agent that values it most. Informational failure in a market can be observed. Of course this result alone says nothing at all about the likelihood

of informational failure in naturally occurring markets. The result is important because it demonstrates that the tools and theories used to analyze naturally occurring markets were not rejected when put to an important test.

With the existence of the lemons problem documented, the analysis turns to an examination of the conditions that generate it. The lemons phenomena do not automatically go away when firms have an incentive and opportunity to establish a reputation for good quality (conclusion 5). Reputation and brand names are not sufficient devices to guarantee efficient market operation even in the case of experience goods and repeat purchases. Several factors can operate to frustrate the competitive development of reputations. First, the cost of developing a reputation is evident in several markets. Supers must sell at regular prices in sufficient quantity to attract buyers' attention and develop their confidence in the seller's reliability. Of course, this can generate substantial temporary losses. The problem can occur because the market price response must be sufficiently rapid to reward sellers who adopt a strategy of delivering high-grade units, and this price response is not well understood. In fact, the positive responsiveness axiom that states that super deliveries will be rewarded by higher prices or increased demand is not always reliable. This axiom is at the heart of many models as in Klein and Leffler (1981), Nelson (1974), Peltzman (1981), Schmalensee (1978), Shapiro (1980, 1982abc).Buyers might not even respond positively to high-grade deliveries (conclusion 9). Instead of understanding seller motivations or believing that sellers have an interest in reputation development, buyers might regard sellers as being totally random or buyers might even avoid sellers who deliver Supers on the belief that the sellers were attempting to trap the buyer or lure the buyer into paying a high price and then delivering a regular. While we cannot actually document the existence of such extreme buyer skepticism, some of the markets seemed to have that characteristic (*i.e.*, markets 12, 13, 14), and in some cases it might even be justified. In summary, buyer reactions to poor quality deliveries are not as uniformly predictable or as punishing and rewarding as presupposed by some dynamic models such as the quality guaranteeing price (conclusion 7).

How a policy might alter belief and learning processes or even buyer reactions to seller strategies is an open question. Marketing programs or regulatory policies that "properly frame" the problem that buyers face might be important. Conceivably the very existence of some sort of regulation, even if unenforced, is a type of public information that might foster buyer confidence in seller intentions and also foster seller beliefs about buyer reactions to "ripoffs." With such changed beliefs the market would possibly provide the proper rewards for quality such that further regulation would be unnecessary. Because the participants have incomplete information, multiple equilibria might exist, and the existence of multiple equilibria might be the source of confirming results. A publicly stated regulation might serve as a focal point that coordinates actions toward one of the equilibria. At this point theory provides very few hints and the issue is appropriate for more experimentation.

Buyer confidence and learning is just part of the reputation cost problem. The confidence must be translated into price increases. Once buyers recognize a seller who reliably delivers Supers, the price of that seller's units must adjust sufficiently rapidly to reduce the reputation cost. Data from experiments (Plott, JEL 1982) leads one to suspect that this price adjustment property is sensitive to market organizational features independent of any learning properties of buyers. The cost of reputation development depends upon the speed of price adjustment in response to changed buyer beliefs. Price adjustment speed appears to be related to market organization. Therefore reputation costs and the resulting evolution of quality products might be sensitive to market organization. Thus, empirical reasons exist for economists to have some interest in market organization, in addition to the theoretical propositions about the relationship between quality and market organization developed by Wilson (1980).

A second factor that can prevent reputation development from guaranteeing market efficiency is a type of externality that seems to exist in some markets. Individual seller success can be related to a market reputation for delivering Supers as well as to the individual seller's own reputation (conclusion 8). The externality can work negatively in two ways. First, individual sellers have an incentive to free ride on the reputations and markets developed by others. After one or two sellers have incurred the cost of reputation development and are successfully selling supers at a high price, an entrant can coat-tail on their reputations. Buyers will test units of entrants priced just below the price at which Supers are being sold (price is a signal) and if the entrant delivers Supers, its reputation is almost costlessly established. The free rider aspect can dampen the development of reputations and the resulting market efficiency. The externality also can work negatively on a seller that has an established reputation. If other sellers decide to destroy their reputation by dumping regulars and thereby make a profit on the ripoffs, buyer reaction can be negative toward all firms. Even sellers that continue to deliver Supers can experience a drop in demand as buyers appear to become suspicious of all firms. This negative externality can depress the returns from reputation development. Whether or not alternative market organization, public announcements, or regulations can effectively promote the development of quality by reducing such externalities awaits further experimentation.

A third potential problem is structural and derives from the problems discussed above. If quality improvements can only be achieved by large and discrete increases in cost, markets might equilibrate at local equilibria that have the lemons property. The large discrete increases in cost mean that the cost of quality improvements can be covered only by large changes in price. Either the buyer must be willing to take a risk and pay a premium in hope that the seller will deliver a Super or the seller must incur large losses by selling Supers at regular prices in order to build buyer confidence. Risk aversion on both sides will make reputation development and the resulting high quality difficult. In markets in which the relative cost of Supers is lowered, the instances of super sales and resulting

reputation-like behavior in the market becomes much more pronounced (conclusion 13).

A final problem also derives from the others listed above when supplemented by the fact that multiple markets are involved. If buyers are optimistic and bid prices high even in the face of many regular deliveries, sellers have no incentive to develop a reputation for delivering Supers. The difference between the going prices of units that are being delivered as Regulars and the maximum value that one might get from a Super is not enough to cover the cost differential (*see* markets 12, 13). Before a reputation is worthwhile, buyer optimism must be dampened and the prices must fall to a point that makes reputation development profitable. Complete market quality deterioration, all lemons, might be a necessary condition for automatic market recovery. Commentators with a taste for paradoxical statements could say that things cannot get better until they get worse; or regulation is needed least when market performance is at its worst.

Market reputation development may be difficult in some circumstances, but it is certainly not impossible. In some of the markets knowledge of seller identification alone (brand names) was sufficient to guarantee behavior consistent with the full information model (conclusions 5 and 13). This opens a possible role for third party actions that facilitate such reputation development. Reputation development is clearly a tool but we do not know its exact limitations. Enforced warranties also will induce the market behavior that is captured by the full information model (conclusion 1). Markets that are otherwise behaving in a confusing and inefficient manner recover almost immediately when enforced warranties are introduced. The power of the instrument in fostering market efficiency is remarkable.

Legal instruments or practices that have the effect of a costlessly enforced warranty will be voluntarily offered by sellers. Such warranties, if they exist, will also be voluntarily demanded by buyers (conclusion 3). Such instruments require that any disclosures made are truthful. Competition, in turn, forces disclosures. The data in these experiments suggest that the Grossman/signaling models that predict the voluntary use of such instruments (when their availability is publicly known) are reliable in this respect as models of warranty-like instruments. We are thus not too far from an understanding of the process through which the warranty-like instruments have an effect on markets. Further support for this type of theory has substantial ramifications for regulatory policy because a direct implication of the theory, when applied to experience goods as opposed to credence goods, is that mandatory disclosure is unnecessary.

Markets need not be characterized by either the full information model or the lemons model. The reasons for such confusing behavior are not understood. Of course one can speculate that it reflects a lack of sophistication on the part of market participants or a lack of experience, or a number of things idiosyncratic to the population (conclusion 11). The problem could be due to the existence of multiple Bayes equilibria as was mentioned above. These are just

speculations that call for more detailed investigation. Precisely because the behavior of such markets is not understood, it is necessary for policy analysts to know when standard principles can only be applied with substantial precautions. Markets that behave in understood patterns are characterized by either private reputation formation or market reputation formation or both (conclusion 9).

Our final observation is related to advertising. False advertising exists in our markets (conclusion 4) even when buyers quickly and easily detect the deception. Thus policy analyses (Posner 1973, 1979) or models (Nelson 1970, 1974) that imply that false advertising cannot be sustained or will be beneficial are not supported by our results. We hasten to add that conditions relied upon by Nelson were not present in our markets and invites further experimentation.[13] Though false advertising occurred and the effects were not beneficial, the effects (for experience goods) are not as deleterious as presupposed by some advocates of advertising regulations. People are not misled. They simply dismiss all sellers' claims so that advertising fails to provide effective information which could enhance efficiency. This last finding may provide some insight into the advertising industry's strongly voiced support for the FTC's advertising substantiation program.[14]

Appendix

Experiment Instructions

GENERAL

This is an experiment in the economics of market decision making. Various research foundations have provided funds for this research. The instructions are simple and if you follow them carefully and make good decisions you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment.

In this experiment we are going to conduct a market in which some of you will be buyers and some of you will be sellers in a sequence of market days or trading periods. Attached to the instructions you will find some sheets, labeled Buyer or Seller, which describe the value to you of any decisions you might make. *You are not to reveal this information to anyone.* It is your own private information.

The type of currency used in this market is francs. All trading and earnings will be in terms of francs. Each franc is worth _____ dollars to you. Do not reveal this number to anyone. At the end of the experiment your francs will be converted to dollars at this rate, and you will be paid in dollars. Notice that the more francs you earn, the more dollars you earn.

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[13] The conditions are that advertising is costly and sellers can increase market share.

[14] *See Advertising Age*, November 1, 1980, p. 40; *Television/Radio Age*, November 29, 1982, p. 35.

SPECIFIC INSTRUCTIONS TO BUYERS

During each market period you are free to purchase from any seller or sellers as many units as you might want. The value of a unit depends upon its grade. There are two grades (Regular and Super) and the value of a Super is much greater than the value of a Regular. At the time you buy a unit you will not know the grade but (*at the end of a trading period*) (*after the purchase*) you will be told the grade of each unit you bought.

The attached information and record sheet will help you determine the value to you of any decisions you make. Page ____ of your information and record sheets contains two schedules. The schedule in the left column identifies the redemption values of Regulars and the schedule in the right hand column contains the redemption values for the Supers. The redemption value of the first Regular you purchase is in the row marked First Units and the column marked Regular. The redemption value of the first Super you purchase is found on the same row only, under the column marked Supers. The redemption value of second units are found in the second row, etc. The profits from each purchase (which are yours to keep) are computed by taking the difference between the redemption value and the purchase price of the unit bought. That is,

your earnings = (redemption value) - purchase price.

In addition to these earnings you will receive a capital payment of _____ francs each period.

Suppose, for example, the redemption value for your first Regular is 1000 and the redemption value for your first Super is 4000. If you buy two units at 1200 and one is a Regular and one is a Super your profits are

1000 - 1200 =	-200
4000 - 1200 =	2800
TOTAL	2600

Turn now to the second page of the information and record sheet. The purchase price of the first unit you purchase should be listed in row two for the first unit purchased. The purchase price of the second unit should be listed in row 2 of the second unit, etc. When the grades of units become known you should enter the redemption values in rows 1 for each unit. If, for example, your first unit purchased is a Super and if your second purchase is a Regular, you record the redemption value for the first Regular because even though the unit is the second purchase it is only your first Regular. Profits at the end of the period should be recorded at the bottom of the page.

SPECIFIC INSTRUCTIONS TO SELLERS

During each market period you may sell to any buyer or buyers as many as _____ units. There are two types of units, Supers and Regulars. Each Super

will cost you _____ and each Regular will cost _____. Notice that the cost of Supers is more than the cost of Regulars. The profits or losses on each sale (which are yours to keep) are computed by taking the difference between the price at which you sold the unit and its cost.

Your total profits for a market period are computed by adding the profits or losses on each sale during the period. The attached record sheet will help you keep track of your profits or losses. Enter the price of the first unit you sell in the appropriate column (Super or Regular) in row 1 at the time of sale. Then record the profit or loss as directed in row 3. The sale price of the second unit should be listed in the appropriate Super or Regular column in row 4. Profits should be similarly calculated and the total for the period recorded in row 16. All profits over _____ are yours to keep.

MARKET ORGANIZATION

The market for this commodity is organized as follows. The market will be conducted in a series of trading periods. Each period period lasts for at most _____ minutes. Any buyer is free at any time during the period to make a bid to buy the commodity at a specified price, and any seller with units to sell is free to accept or not accept the bid. Likewise, anyone wishing to sell a unit is free to make an offer to sell one unit at a specified price. All bids and offers are entered on the blackboard and remain there until accepted or canceled. If a bid or offer is accepted, a binding contract has been closed for a single unit at the specified price and the contracting parties will record the contract price. Any ties in bids or acceptances will be resolved by random choice. Except for the bids and their acceptance or cancellation you are not to speak to any other subject. There are likely to be many bids that are not accepted, but you are free to keep trying. You are free to make as much profit as you can.

Trading period 0 will be a trial period to familiarize you with the procedure, and will not count toward your cash earnings.

FINAL OBSERVATIONS

1. (*At the end of the period*) (*After each sale*) sellers indicate to the experimenter those trades that involved Regulars and those that involved Supers. This information will be transmitted to the buyers who participated in those transactions. Buyers can then calculate their profits.

2. Each individual has a large folder. All papers, instructions, records, etc, should be put into this folder. Leave the folder with us before leaving. *Take nothing home with you.*

3. We are able to advise you a little on making money. First, you should remember that pennies add up. Over many trades and a long period of time very small amounts earned on individual trades can add up to a great deal of money. Secondly, you should not expect your earnings to be steady. You will have some good periods and some bad periods. During bad times try not to become frustrated. Just stay in there and keep trying to earn what you can.

It all adds up in the end.

Some people rush to trade. Others find it advantageous to "shop" or spread their trading over the period. We are unaware of any particular "best" strategies and suggest that you adapt accordingly.

4. Under no circumstances may you mention anything about activities which might involve you and other participants after the experiment (*i.e.*, no physical threats, deals to split up afterwards, or leading questions).

5. Each individual will be paid in private. Your earnings are strictly your own business.

6. Buyers tender bids verbally by indicating in sequence "(buyer number) BIDS (amount)."

7. Sellers tender offers verbally by indicating in sequence "(seller number) OFFERS (amount)."

8. Each trade in a period will be numbered. (*At the end of the period*) (*after each sale*) each seller will (*submit a slip of paper*) (*hold up a card*) for each trade specifying a Super or a Regular. The seller is free to determine the grade of the units he sells and may mix grades within or between periods.

Trader No. _____

R S

Buyer _____ Seller_____

INFORMATION AND RECORD SHEET

RECORD SHEET FOR SELLER NO._____

Unit Sold			Market Period							
			1		2				18	
			Super	Regular	Super	Regular			Super	Regular
1st	1	sales price								
	2	cost								
	3	profit/loss (row 1-row 2)					. . .			
2nd	4	sales price								
	5	cost								
	6	profit/loss (row 4-row 5)								
			.						.	
			.						.	
			.						.	
	13	total profit/ loss per item								
	14	total profit/ loss					. . .			
	15	deduction per period								
	16	net profit								

INFORMATION AND RECORD SHEET

RECORD SHEET FOR BUYER NO._____

Unit Purchased			Market Period							
			1	2	3	4	5		17	18
1st	1	redemption value								
	2	purchase price								
	3	profit/loss (row 1 - row 2)								
2nd	1	redemption value								
	2	purchase price								
	3	profit/loss (row 1 - row 2)								
5th	1	redemption value								
	2	purchase price								
	3	profit/loss (row 1 - row 2)								
	1	period profit								
	2	capital payment								
	3	total								

Name_____ Soc. Sec. No._____ Total Payment_____

Address_____

INFORMATION AND RECORD SHEET

	Regular	Super
1st units redemption value		
2nd units redemption value		
3rd units redemption value		
. . .	. . .	. . .
8th units redemption value		
Capital payment per period_____		

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